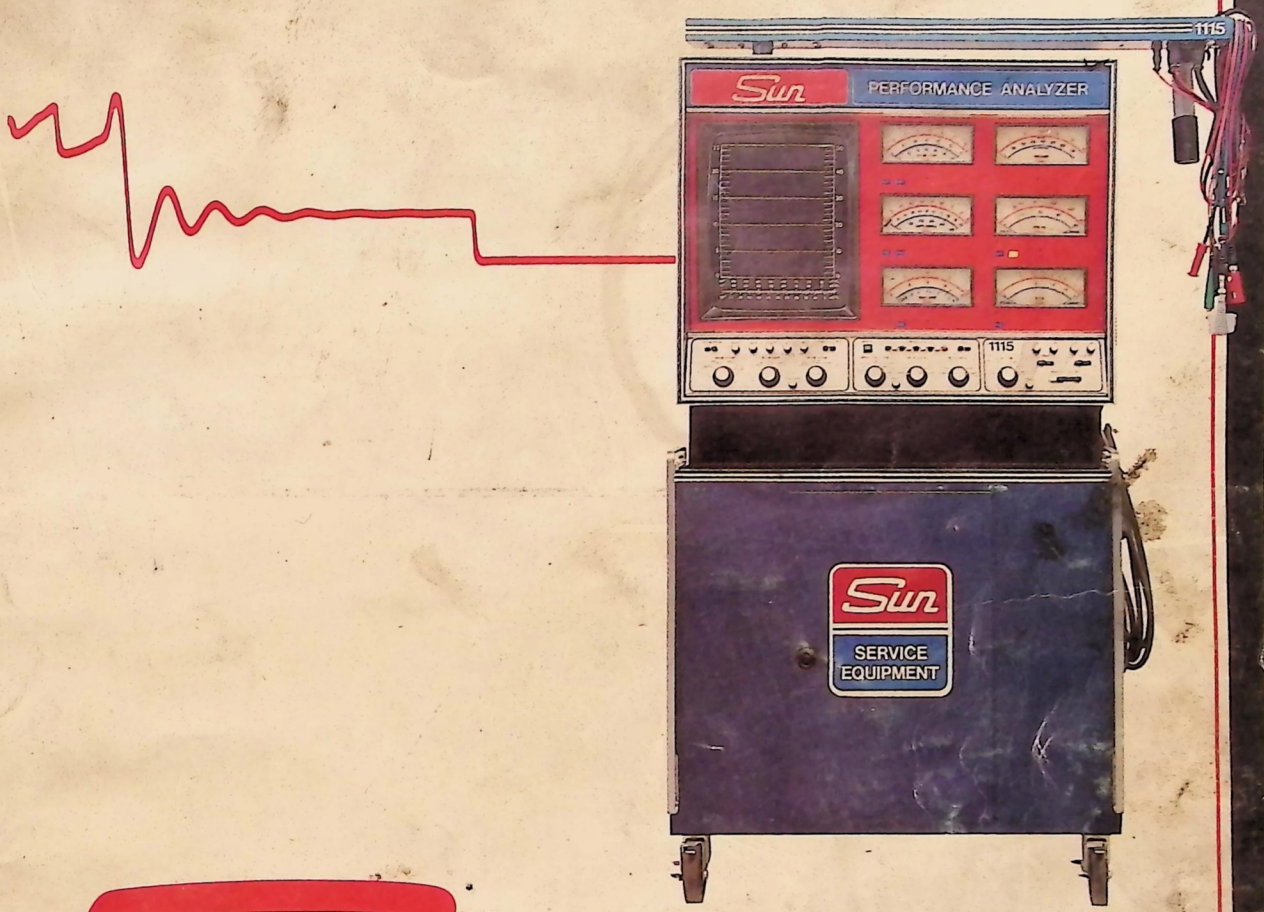

Sun 1115

PERFORMANCE ANALYZER

OPERATOR'S MANUAL

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PERFORMANCE ANALYZER
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NOTE: Before making any corrections and/or adjustments to the various engine components directly relating to the emission controls of the vehicle, please refer to the manufacturer's guidelines and/or specifications.

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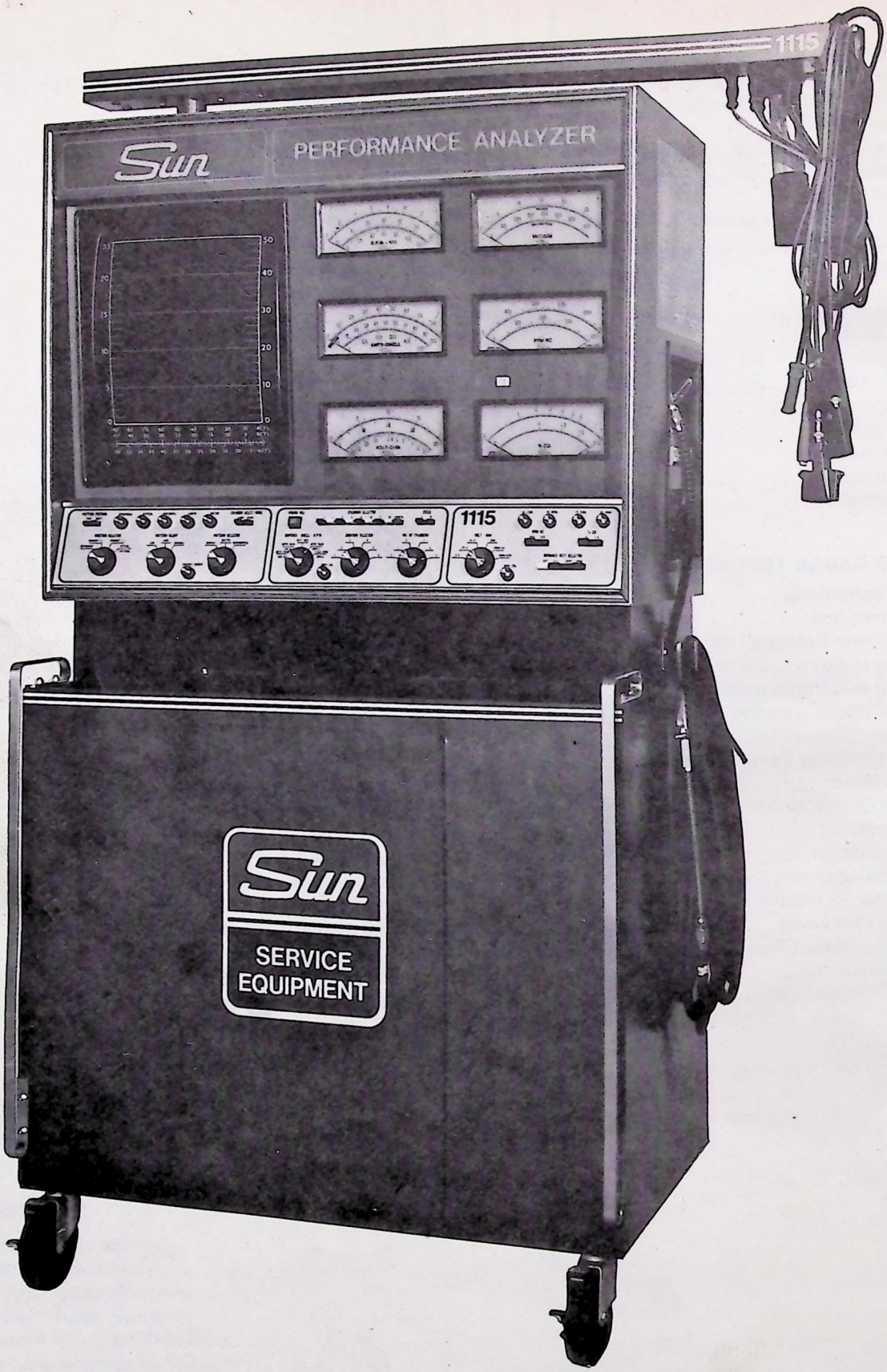


FIGURE 1—The Sun 1115 Performance Analyzer consisting of an analog scope section (left) and a meter and gauge section (right).

GENERAL INFORMATION

OPERATOR'S MANUAL

This manual will assist you to quickly become familiar with the SUN 1115 Tester. The GENERAL INFORMATION and AREA TESTING sections are your key to understanding your tester. The GENERAL INFORMATION section gives the location and function of each control and gauge. The AREA TESTING section shows you how to connect the tester to the vehicle and how to perform a series of important tests that are used to check out an engine. These area tests are used to:

1. Determine overall engine performance prior to service work.
2. Determine what systems are failing and need further testing.
3. Determine if any important step was overlooked during service work by quality control testing after service work is completed.

Sun's Specifications and other published materials along with the information in the remaining sections of this manual provide you with the detailed testing methods needed to thoroughly test a vehicle. Once you have become familiar with area testing, you can do detailed testing to check out any failure or malfunction detected during area testing.

TESTER INFORMATION

The Tester provides electronic testing of the various systems and components of an engine. The tester consists of two sections: the Analog Scope Section and the Meter and Gauge Section. See Figure 1.

HEAD SIGN

A fully illuminated head sign is mounted across the top of the headframe. This sign and the meters and gauges are controlled by the AC Power Switch on the left end panel. The AC Power Switch is a three position switch with Center OFF. With the switch in the left LIGHT ON position, the head sign and meters and gauges will light for tester display purposes. With the switch in the right UNIT ON position, all units in the tester are operative including sign, scope, scale reminders, meters and gauges, etc.

ANALOG OSCILLOSCOPE

The analog scope features a 20-inch screen with greater vertical display capabilities, thus increasing the readability of the raster display by allowing a greater spread of the patterns and making them easier to see (Figure 2). The scope has the facilities for displaying special waveforms for testing alternators, regulators, electronic ignition systems and other electronic systems. It provides methods for testing conventional, transistor, and capacitive discharge type ignition systems.

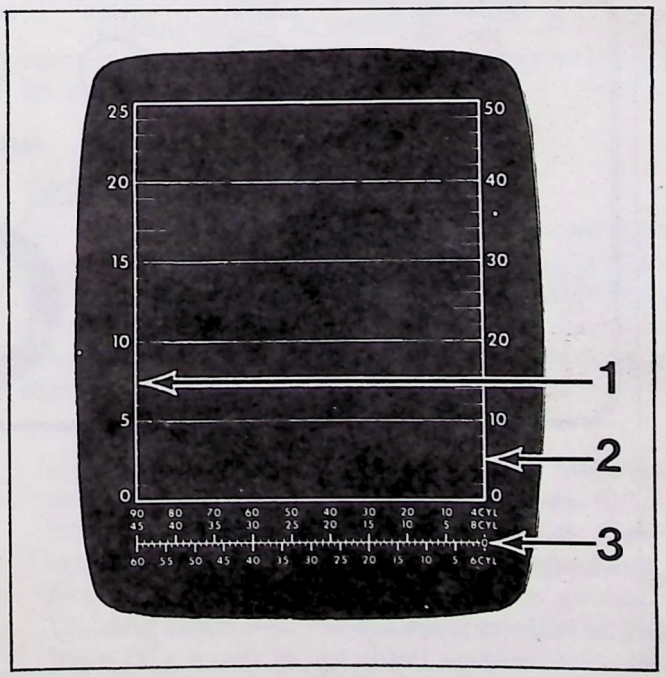


FIGURE 2 — Analog scope screen scales in volts, kilovolts and degrees.

The vertical scale on the left edge of the tube provides a range of 0 to 25 which can be read as 0 to 25 volts or 0 to 25 KV depending on whether primary or secondary waveforms are being viewed. See Figure 2, Item 1. The vertical scale on the right edge of the tube provides a range of 0 to 50 which in turn can be read as 0 to 500 volts in primary or 0 to 50 KV in secondary (Figure 2, 2).

The horizontal eight cylinder dwell scale (Figure 2, 3) reads from 0 to 45° in increments of 1°, the four cylinder scale reads from 0 to 90° in increments of 2° and the six cylinder scale reads from 0 to 60° in increments of 1°.

SCOPE CONTROL PANEL

The scope controls, located on the panel directly below the scope display screen, provide a means of selecting the type of display desired. The scope controls permit high clarity in scope patterns and new methods of displaying ignition waveforms for more accurate analysis (Figure 3).

Function Selector

The FUNCTION SELECTOR (Figure 3, 1) is a four position rotary switch used to select the waveform that is to be displayed on the scope. The first position (SECONDARY) is used when secondary ignition waveforms are to be displayed. The second and third positions (PRIMARY + and PRIMARY —) are used for positive and negative primary waveforms.

The fourth position (SPECIAL PATTERNS) is used to display the special waveforms picked up at the alternator output terminal, or positive battery terminal. The SPECIAL PATTERNS position can also be used for viewing other waveforms such as fuel injection.

Pattern Height

The PATTERN HEIGHT control (Figure 3, 2) is a three position switch used to select the vertical height of the waveform displayed on the scope. When either primary or secondary ignition waveforms are being displayed and this control is set in the LOW position, the left hand 0 to 25 scale on the scope screen is used as a measuring device. When the control is set in the HIGH position, the right hand 0 to 50 scale is used. The VARIABLE position of the control activates the VARIABLE ADJUST knob which provides a means of adjusting the vertical display of any waveform being viewed.

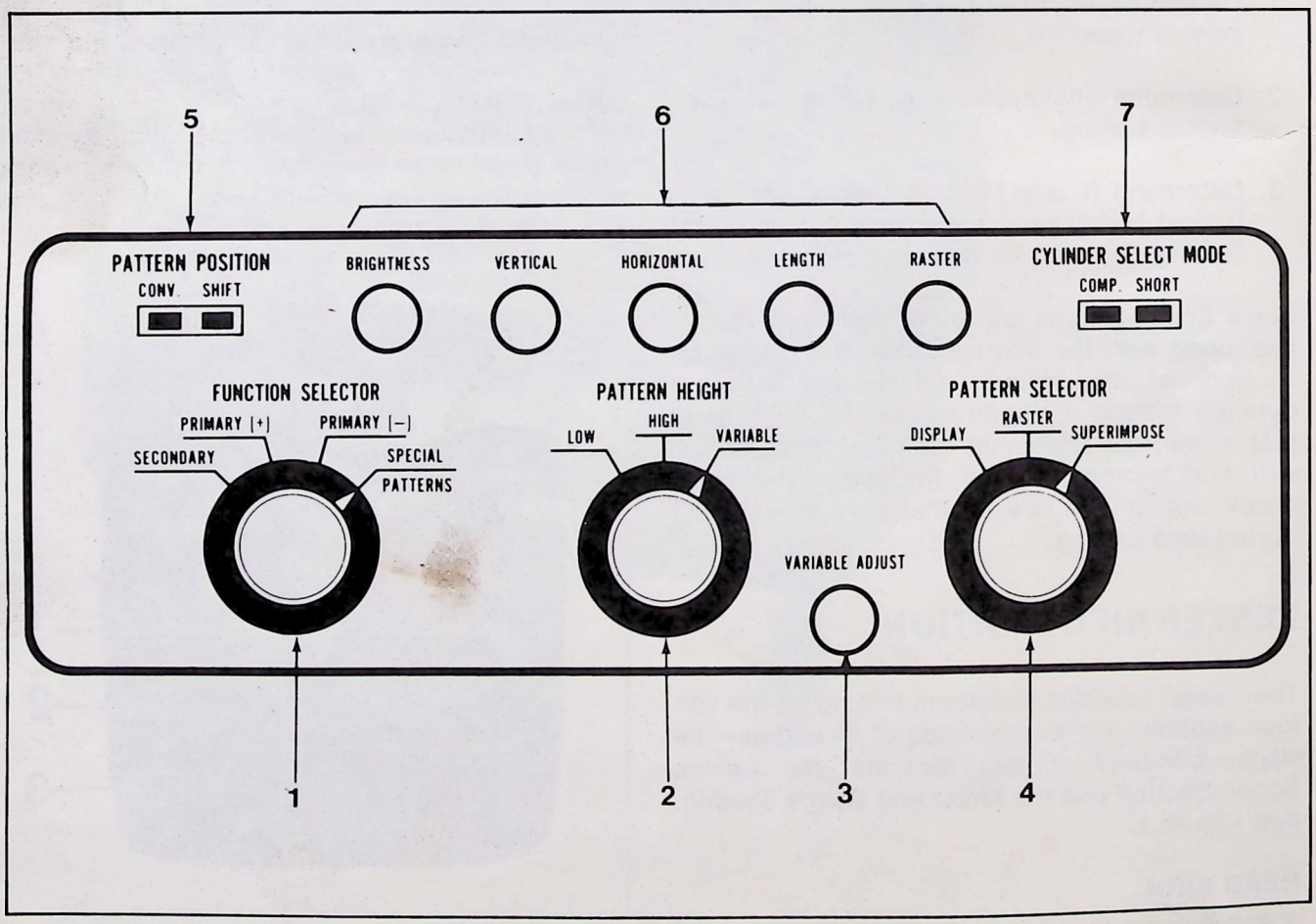


FIGURE 3 — Analog scope panel of controls.

Variable Adjust

The VARIABLE ADJUST knob (Figure 3, 3) provides the means of manually adjusting the vertical height of the pattern being displayed. This control is only operative when the PATTERN HEIGHT knob is set in the VARIABLE position.

Pattern Selector

The PATTERN SELECTOR (Figure 3, 4) is another three position rotary switch which provides a means of selecting "how" an ignition waveform is to appear on the scope screen. In the DISPLAY position, all of the ignition waveforms appear in a horizontal chain across the screen. The #1 cylinder pattern is at the left (except for its firing line) and the other cylinder patterns follow to the right in the engine's firing order.

In the RASTER position, all cylinder patterns are viewed at full screen width. The pattern of #1 is at the bottom, and the other cylinder patterns are evenly spaced above, again in the engine's firing order.

In the SUPERIMPOSE position, all cylinder patterns are placed one behind the other on the zero line of the scope screen.

Pattern Position

The PATTERN POSITION control (Figure 3, 5) consists of two buttons (CONV and SHIFT). In RASTER and SUPERIMPOSE when the CONVENTIONAL (CONV) button is depressed, the ignition patterns displayed will begin with the spark line on the left end of the pattern and the firing line at the right end of the pattern. Depressing the SHIFT button will result in a pattern shift to the right, causing the waveforms displayed to begin with the firing line at the left. In DISPLAY when the SHIFT button is depressed, the firing line of the #1 cylinder which normally appears at the far right is shifted to the far left.

Five Pattern Adjustment Controls

Directly to the right of the PATTERN POSITION buttons are five pattern adjustment controls (Figure 3, 6), which provide adjustment of the scope's BRIGHTNESS, the VERTICAL position of the waveform displayed, the HORIZONTAL position of the waveform, the LENGTH of the waveform, and the spacing between waveforms when they are displayed in the RASTER mode.

Cylinder Select Mode

The CYLINDER SELECT MODE (Figure 3, 7) allows the selection of two buttons, a SHORT button and a COMPARE button. With the SHORT button depressed, the 8 buttons on the CYLINDER SELECTOR on the center panel of tester are used to short out the engine cylinders required to do a cylinder power balance test. With the COMPARE button depressed, the 8 buttons on the CYLINDER SELECTOR are used to select display patterns on the scope.

By depressing the SHORT button and selecting an individual or a group of buttons on the CYLINDER SELECTOR, the ignition for the corresponding engine cylinders is electronically shorted out. Shorting cylinders individually or in groups provides an accurate and convenient means of determining the comparative overall operating efficiency of each engine cylinder.

Depressing the COMPARE button switches the function of the CYLINDER SELECTOR to permit it to alter the waveform pattern displayed on the scope. For example, with ignition system waveforms being viewed in the DISPLAY manner, pushing any one of the CYLINDER SELECTOR buttons will cause the corresponding cylinder waveform to be removed from the normal display and to appear in an enlarged form, centered and above the others on the scope screen. This feature permits the operator to enlarge any cylinder's pattern as desired for more detailed examination. The COMPARE button also allows two or more cylinders to be superimposed for close comparison. Releasing the CYLINDER SELECTOR button permits the enlarged waveform to again return to its usual position in the display.

OSCILLOSCOPE PATTERNS

The Sun Analog Scope provides a convenient means of observing ignition system operation while the engine is running. It displays a graphic waveform trace pattern that is easy to interpret because each part of the waveform represents a specific phase of ignition system operation.

NOTE: For an explanation on how to interpret scope waveform patterns refer to Sun's Automotive Testing And Diagnosis manual. Generally, there are three basic waveform patterns, one where there is no intermediate section, Chrysler Electronic, for example, another where there is a hump in the dwell section, HEI, for example, and the old conventional ignition system waveform.

Display Pattern

With the PATTERN POSITION CONV button depressed, the PATTERN SELECTOR knob set at DISPLAY, the PATTERN HEIGHT knob at HIGH, and the FUNCTION SELECTOR knob at SECONDARY, the scope will present a parade of all cylinders as shown in Figure 4.

NOTE: The scope patterns presented are of the secondary ignition circuit with the engine running at approximately 1500 rpm.

With the TRIGGER PICKUP clamped around the number one spark plug wire, the waveform viewed on the scope screen will begin on the left with the pattern for number one cylinder. However, it should be noted that the firing line of number one cylinder is displayed at the extreme right end of the trace. The trace moves from left to right displaying the ignition cycles of each cylinder consecutively in the engines firing order until all cylinders are displayed on the screen.

If the operator wishes to move the number one cylinder's firing line from the extreme right to the left of the screen, all he need do is push the PATTERN POSITION SHIFT button. Now the display pattern has the firing line of the number one cylinder at the extreme left as shown in Figure 5.

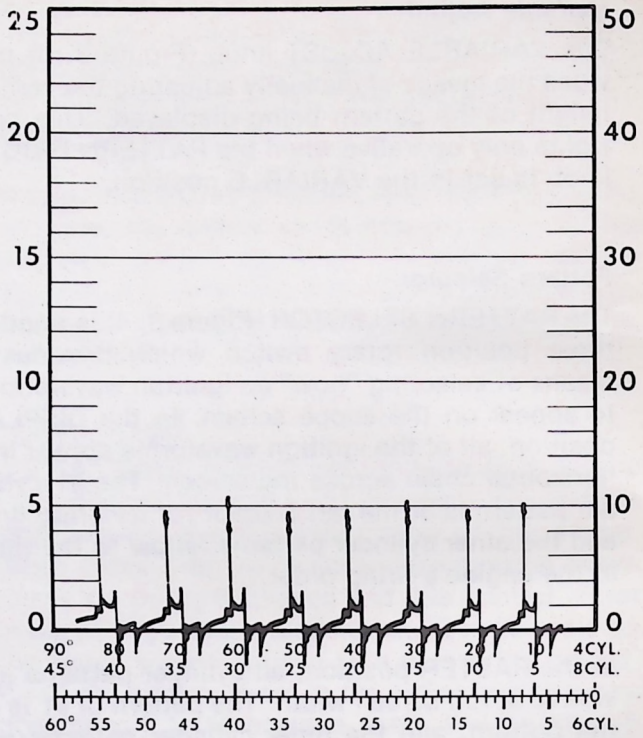


FIGURE 5 — Display pattern of normal engine using HEI ignition with shift button depressed.

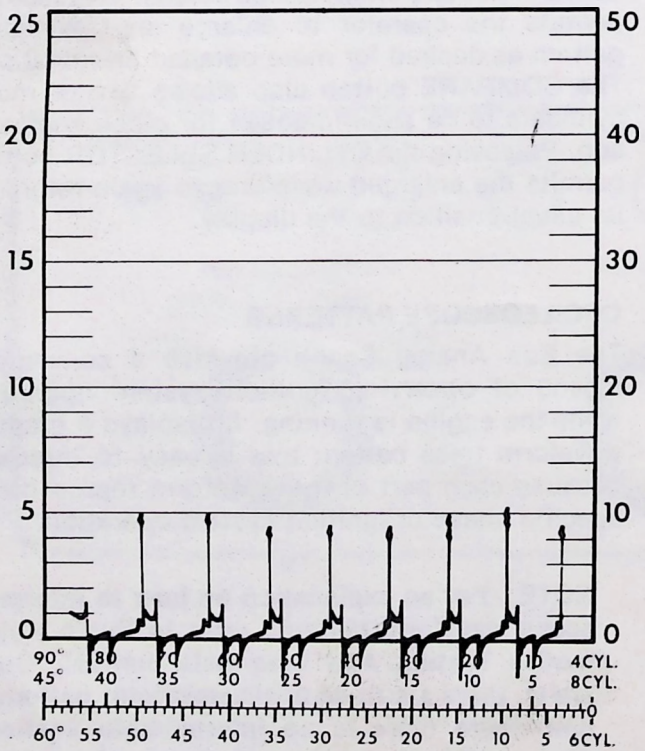


FIGURE 4 — Display pattern of normal engine using HEI ignition.

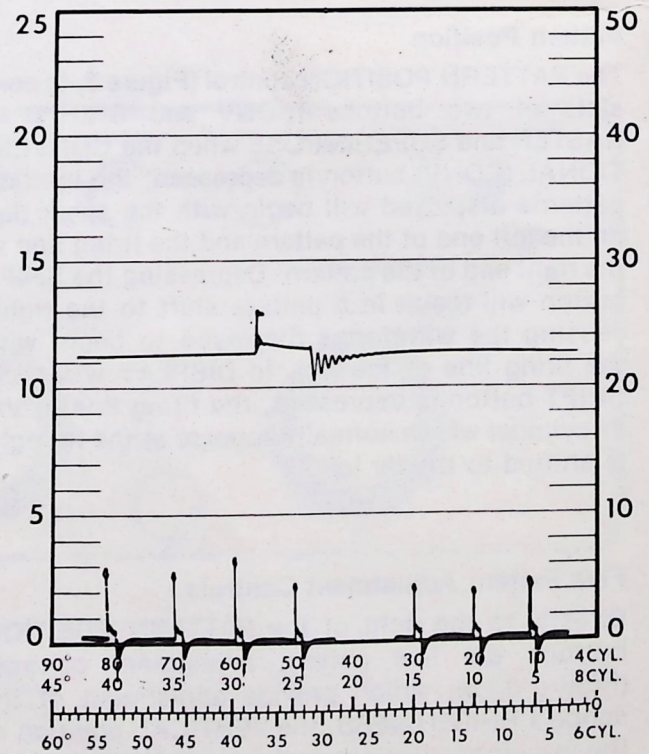


FIGURE 6 — A display pattern with the shift button, the compare button, and the number five cylinder button of the cylinder selection control depressed.

If the operator wishes to move one of the cylinder traces from the parade display and extend it across the screen, he may push the CYLINDER SELECT MODE COMP button and the button number of the CYLINDER SELECTOR control which corresponds to the number of the cylinder that the operator wishes to view. This cylinder's display will then be traced at the top of screen as in Figure 6 which is a display of a Chrysler Electronic Ignition system. Two or more cylinders can be superimposed at the top of the screen for close comparison by pressing more than one CYLINDER SELECTOR button.

The cylinder may also be displayed at the top of the screen without being in the SHIFT condition by pressing all the buttons previously depressed but with the PATTERN POSITION control CONV button depressed. This display is shown in Figure 7 which is of a conventional ignition system.

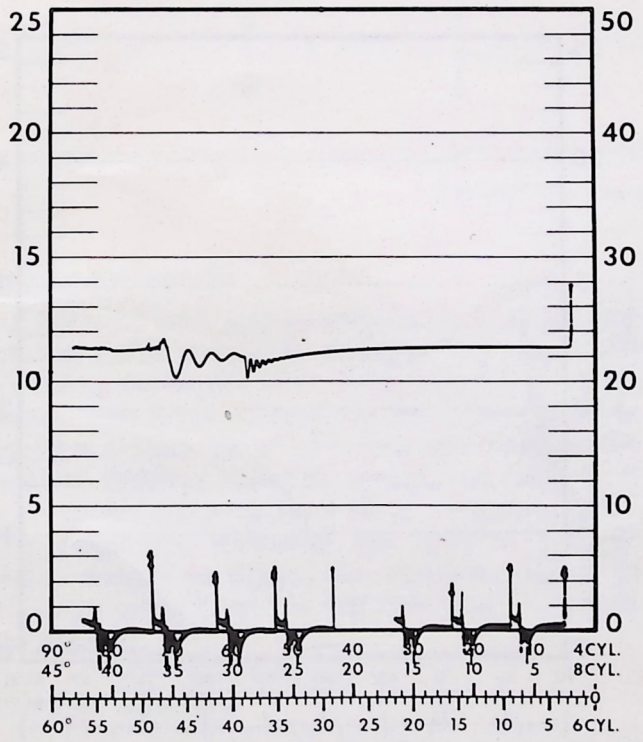


FIGURE 7 — A display pattern with the conventional button, the compare button, and the number five cylinder button of the cylinder selection control depressed.

Raster Pattern

The raster pattern makes use of the vertical size of the scope screen by stacking the cylinder patterns one above the other. All individual patterns are vertically distributed on the screen.

This permits individual cylinder identification while viewing all cylinders at the same time. The raster pattern is especially helpful for cylinder identification of variations in the pattern waveforms observed in the superimposed pattern.

With the TRIGGER PICKUP clamped around number one spark plug wire, the number one cylinder will be displayed at the bottom of the screen. The remaining pattern waveforms will appear in the firing order sequence starting at the bottom and moving to the top of the scope screen.

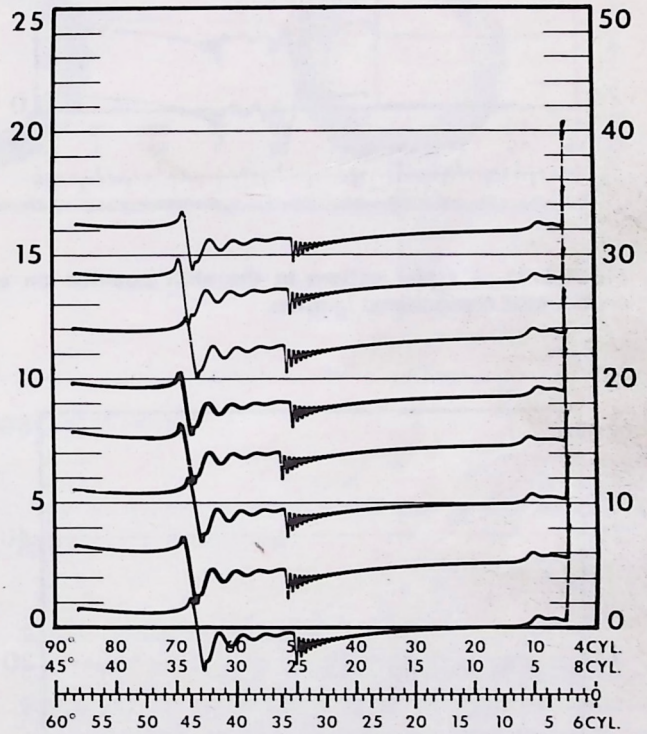


FIGURE 8 — A raster pattern of a normal operating engine with HEI ignition.

By setting the PATTERN SELECTOR knob at RASTER, the PATTERN HEIGHT knob at HIGH, the FUNCTION SELECTOR knob at SECONDARY, and the CONV button depressed, the scope will display a raster pattern (Figure 8). The DISPLAY position of the PATTERN SELECTOR must be used for viewing the firing lines for measuring voltage potentials. The raster pattern in the SHIFT position does show the firing lines but this display is normally used for ease of viewing the cylinder patterns in raster. To get a raster pattern in the SHIFT position program the scope as above but press the SHIFT button (Figure 9).

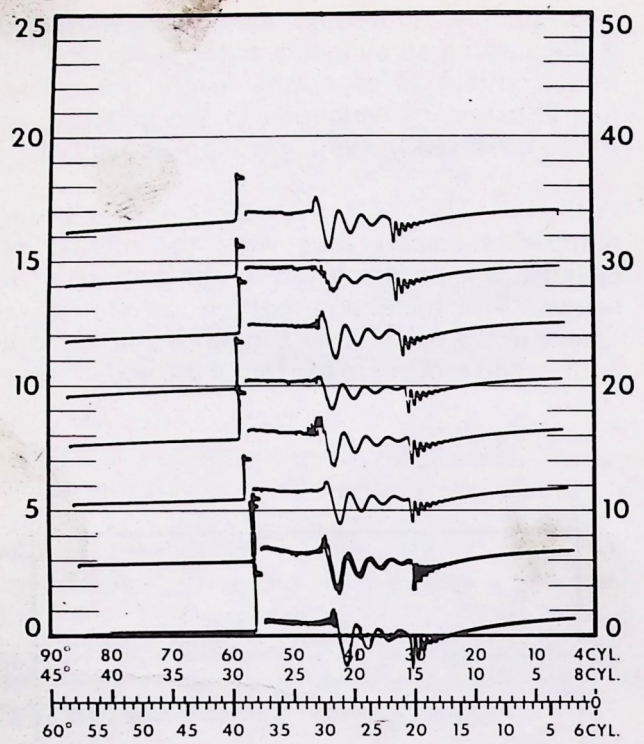


FIGURE 9 — A raster pattern in the shift position on an engine with conventional ignition.

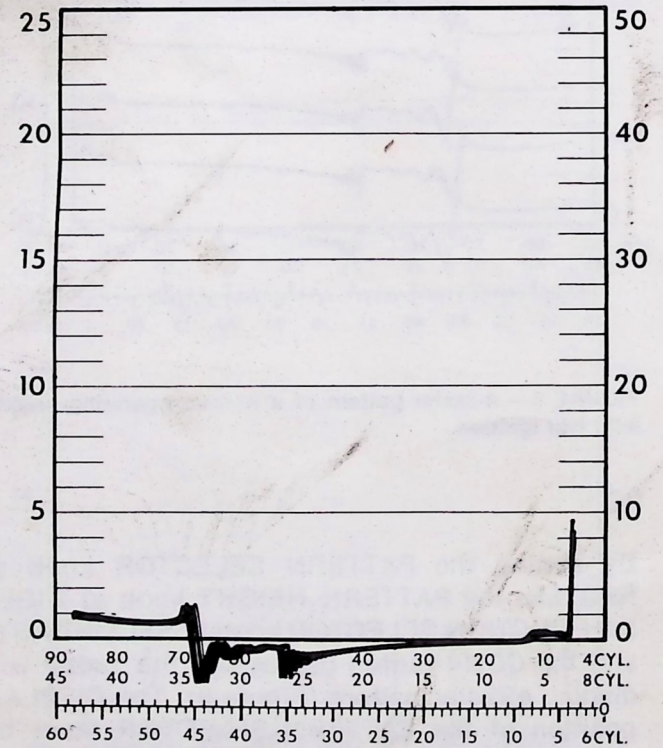


FIGURE 10 — A superimposed pattern of an engine with HEI ignition.

Superimposed Pattern

A superimposed pattern is the display obtained by placing all cylinder patterns one in front, or on top, of the other. Superimposed cylinder patterns provide a convenient method of testing an ignition system for overall uniformity. By having all cylinder display patterns one on top of the other, any variation of any individual cylinder pattern can be easily detected.

To obtain a secondary circuit superimposed pattern, set PATTERN SELECTOR to SUPERIMPOSE, PATTERN HEIGHT to HIGH, FUNCTION SELECTOR to SECONDARY, and push the CONV button on PATTERN POSITION controls (Figure 10). With the analog scope programmed for superimposed as above, a single cylinder display can be obtained by pushing the COMP button and one of the cylinder buttons on the CYLINDER SELECTOR. This gives a display of a single cylinder. The operator can view any single cylinder display by depressing the corresponding cylinder button on the CYLINDER SELECTOR. This cylinder will be displayed below the zero line on the dwell scale (Figure 11).

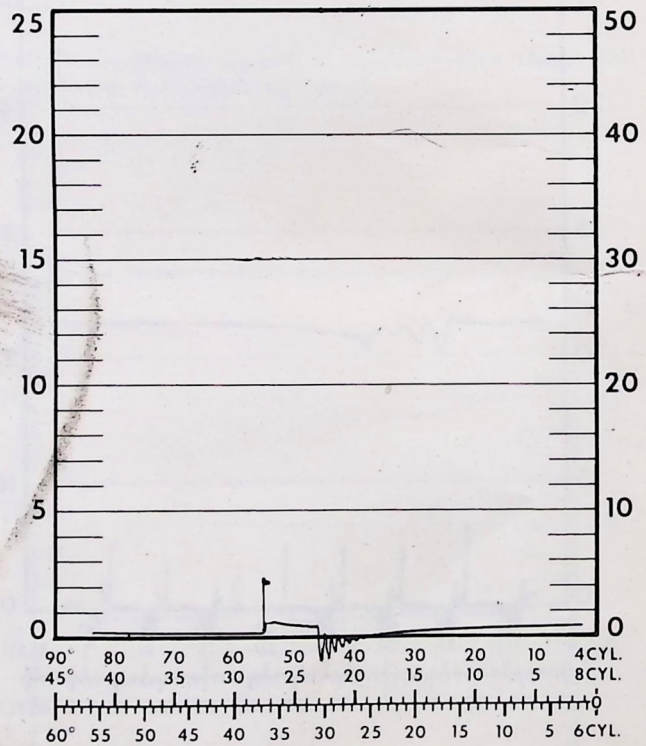


FIGURE 11 — A single cylinder display obtained from superimposed pattern in compare (engine with Chrysler electronic ignition).

CENTER PANEL CONTROLS

The tester's center panel of controls (Figure 12) is used to select the type of engine and number of cylinders to match the vehicle being tested. This panel also contains controls to select additional tester functions.

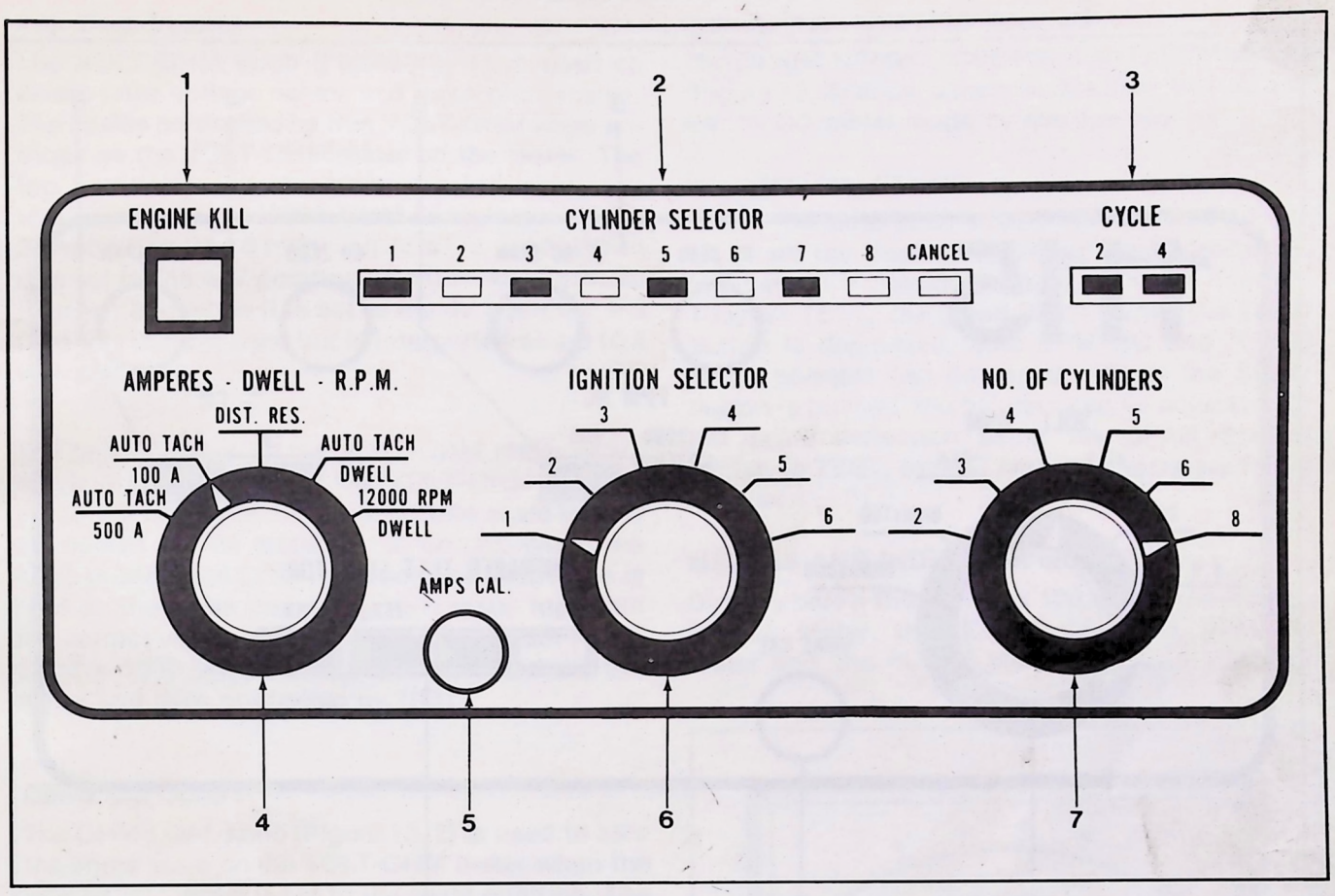


FIGURE 12 — The center panel of controls.

Engine Kill Button

An ENGINE KILL button (Figure 12, 1) is located on the panel to provide a convenient means of stopping the engine if an unexpected emergency arises. The ENGINE KILL control shorts out the ignition system for all cylinders and disables the engine. Besides being an emergency feature, it also allows cranking tests to be performed without physically disabling the ignition system. When button is Green, the ignition system is enabled. When button is Red, the ignition system is disabled.

Cylinder Selector

At the top of the panel, directly to the right of the ENGINE KILL button, is a series of nine buttons, identified as a CYLINDER SELECTOR (Figure 12, 2).

The buttons identified by numbers 1 through 8, are of the push-to-set, push-to-release type. These can be set and released individually, or in any combination desired. The ninth button, identified as CANCEL, is used to simultaneously release all buttons at once. These CYLINDER SELECTOR buttons are used in conjunction with the two CYLINDER SELECT MODE buttons located in the control panel below the scope as previously described.

Cycle Selector Buttons

The CYCLE control selector buttons (Figure 12, 3) are used to select the type of ignition system being tested. It is a two button control used to program the tester for 4 cycle or 2 cycle/rotary type ignition systems.

Amperes-Dwell-RPM Control

The AMPERES-DWELL-RPM controls (Figure 12, 4) is a rotary knob used to select testing of amps, engine speed, dwell, or point resistance. The control knob has five positions which are used to select the type of readings being indicated on the AMPS-DWELL meter.

The two bottom scales on the DWELL-AMPS meter are for measuring amperes when the AMPERES-DWELL-RPM knob is in either the AUTO-TACH/100A or AUTO-TACH/500A position. The scale at the top of the meter has a DIST RES (distributor resistance) section and a Dwell Section calibrated in degrees. This scale is operative when the AMPERE-DWELL-RPM knob is set

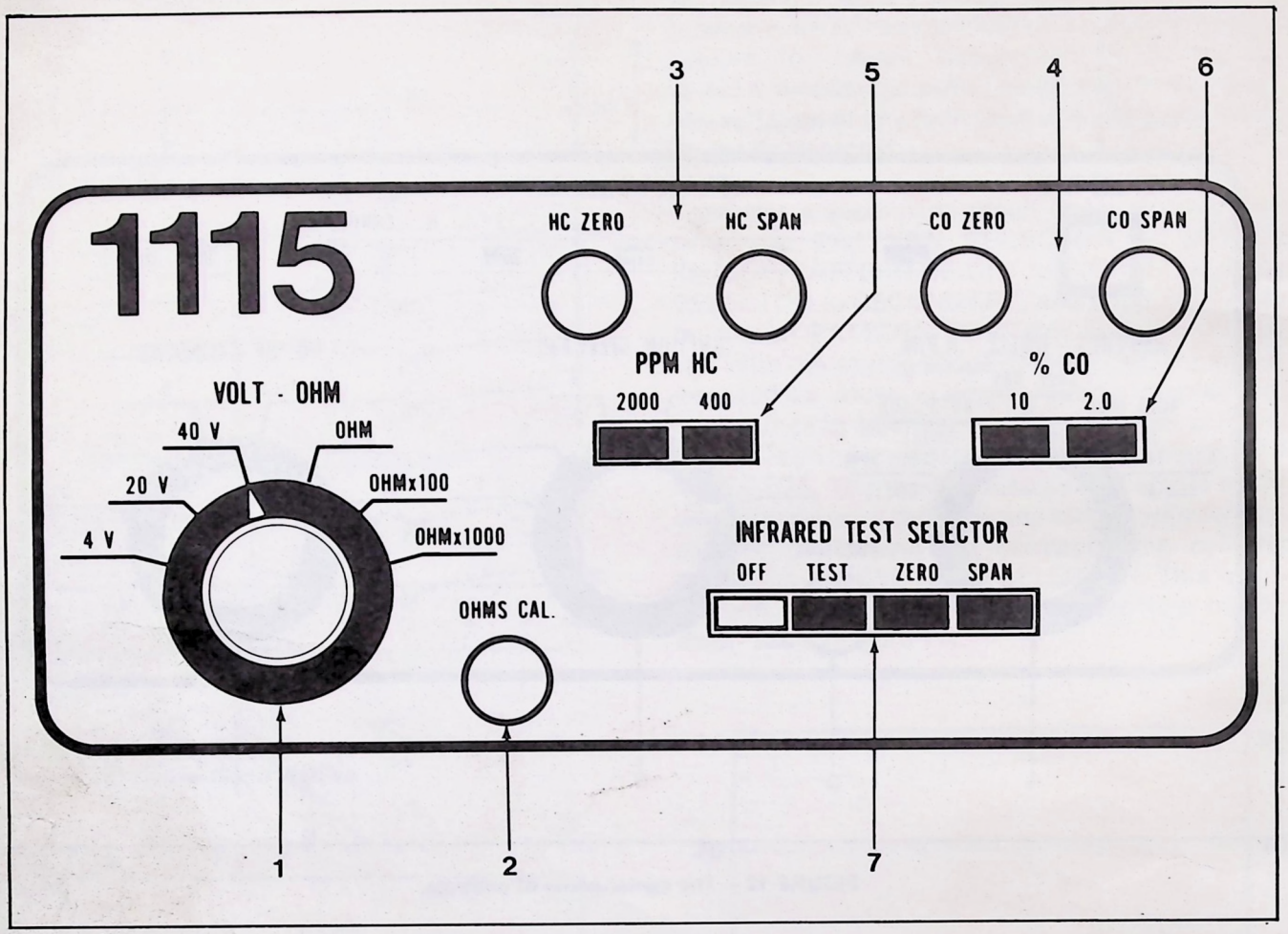


FIGURE 13 — Right panel controls.

at DIST RES or either the AUTO-TACH/DWELL position or the 12000 RPM/DWELL position.

Amps Calibration Control

The AMPS CAL knob (Figure 12, 5) is used to calibrate the ampere meter scale electrically. With the AMPERE-DWELL-RPM knob in the AUTO-TACH/100A position, the AMPS CAL knob is used to set the AMPS-DWELL meter pointer to zero. This is done before the tester leads are hooked to the vehicle.

Ignition Selector Control

The IGNITION SELECTOR (Figure 12, 6) is used to select the testing circuit of the tester that matches the type of ignition used on the test vehicle. This control is a six position knob, having positions numbered 1 through 6. Position #1 is for all U.S. production systems, except General Motors HEI and Prestolite BID ignition systems. Prestolite is used as original equipment on American Motors, Jeep, and International Harvester, and is sold as an aftermarket system for many vehicles. Position #2 is used on any ignition that has voltage increases or humps occurring during the dwell portion of the waveform, such as the Delco-Remy HEI and Prestolite BID Ignition systems.

Position #3 provides a capability opposite to Position #1 in that the primary signal takes precedence over the secondary, providing a possible use on systems that will not trigger properly in positions #1 or #2. Position #4 provides a low level primary for use on Capacitive Discharge (CD) systems. Position #5 and #6 are wired the same as Position #2 at this time.

Number Of Cylinders Control

The NO. of CYLINDERS knob (Figure 12, 7) is a six position rotary switch used to select the testing circuit of the tester that matches the number of cylinders used in the test vehicle. The knob positions stand for the number of engine cylinders.

RIGHT PANEL CONTROLS

The tester's right panel of controls (Figure 13) is used to select the volts and ohm ranges to be used as well as the controls for testing hydrocarbons and carbon monoxide.

Volt-Ohm Control

The VOLT-OHM knob (Figure 13, 1) is used to select three voltage scales and three ohm scales. The scales controlled by this VOLT-OHM knob are those on the VOLT-OHM meter on the tester. The top two scales on the meter are for measuring voltage. When the VOLT-OHM knob is set to the 20V position, the 0 to 20 volt scale is used. When it is set to the 40V position, the 0 to 40 volt scale is used; and when it is set to the 4V position, the 0-40 volt scale is used but is interpreted as a 0 to 4 volt scale.

The bottom scale on the VOLT-OHM meter is for measuring ohms. When the VOLT-OHM knob is set to the OHM position, the bottom scale is read as marked on the meter (0-100 ohms). When the knob is set to the OHM x 100 position, the scale is read on the meter and multiplied by 100 to obtain the correct value; and when the knob is set to the OHM x 1000 position, the scale is read on the meter and then multiplied by 1000.

Ohms Cal Control

The OHMS CAL knob (Figure 13, 2) is used to zero the ohms scale on the VOLT-OHM meter when the VOLT-OHM meter is set to the OHM position. The two ohm leads of the tester are clamped together and the OHMS CAL knob adjusted until the pointer is zeroed on the ohm scale. When the VOLT-OHM knob is set to either the OHM x 100 or the OHM x 1000 positions, the tester automatically sets the pointer to zero; that is, these two positions are self-calibrating.

Hydrocarbon Zero And Span

The HYDROCARBON ZERO and SPAN knobs (Figure 13, 3) provide adjustments for the zero and full-scale deflections of the PPM HC meter pointer. These adjustments are needed to insure the accuracy of the hydrocarbon meter for the auto being tested.

Carbon Monoxide Zero And Span

The CARBON MONOXIDE ZERO and SPAN knobs (Figure 13, 4) on the control panel provide a means of adjusting the zero and full-scale deflections of the % CO meter pointer. These adjustment knobs insure accurate carbon monoxide readings of the meter.

Hydrocarbon High And Low

The HYDROCARBON HIGH and LOW buttons (Figure 13, 5) allow the operator to select either the high or low range scale of the PPM HC meter.

Carbon Monoxide High And Low

The CARBON MONOXIDE HIGH and LOW buttons (Figure 13, 6) allow selection of either the high or low % CO meter range by the operator.

Infra-Red Test Selector

The INFRA-RED TEST SELECTOR buttons (Figure 13, 7) are the master control for the hydrocarbon and carbon monoxide exhaust emission meters. They are TEST, ZERO and SPAN. When the ZERO button is depressed, both PPM HC and % CO meter pointers can be zeroed. When the SPAN button is pushed, the pointers can be adjusted for full scale deflection using the SPAN control knobs. In TEST, the HC and CO meters are ready for use.

METERS AND INDICATOR LIGHTS

Directly below the R.P.M. x 100 Meter, the AMPS-DWELL Meter, the VOLT-OHM Meter, PPM HC Meter and the % CO Meter are scale indicator

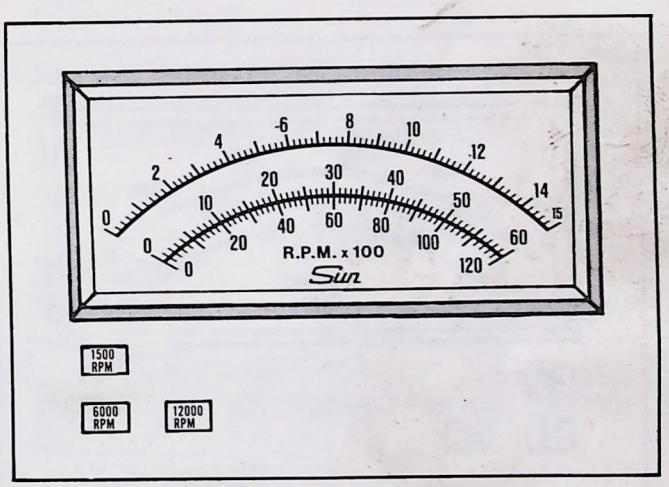


FIGURE 14 — RPM x 100 meter and indicator lights.

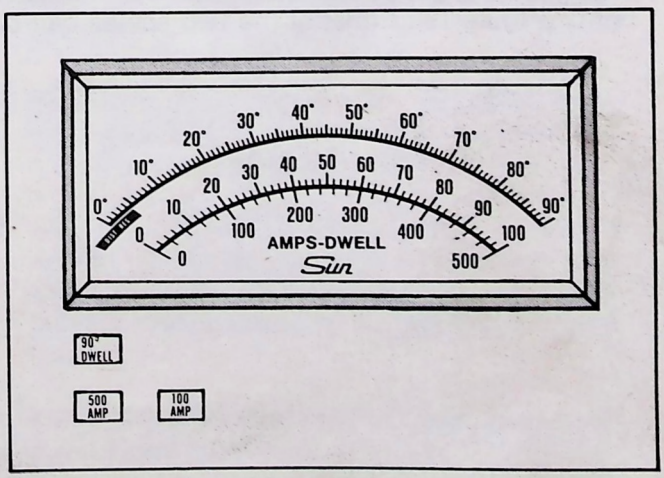


FIGURE 15 — AMPS-DWELL meter and indicator lights.

lights which remind the operator of the scale ranges that are to be read. There is a scale reminder light for each scale of each meter and each indicator light is the same color as the meter scale it indicates. See Figures 14 through 18.

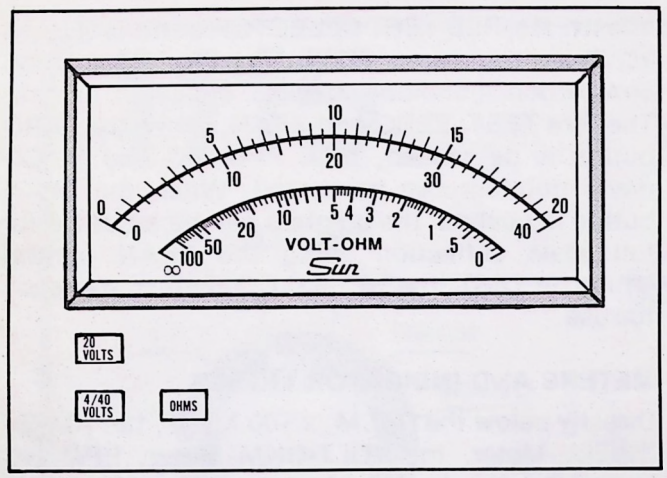


FIGURE 16 — VOLT-OHM meter and indicator lights.

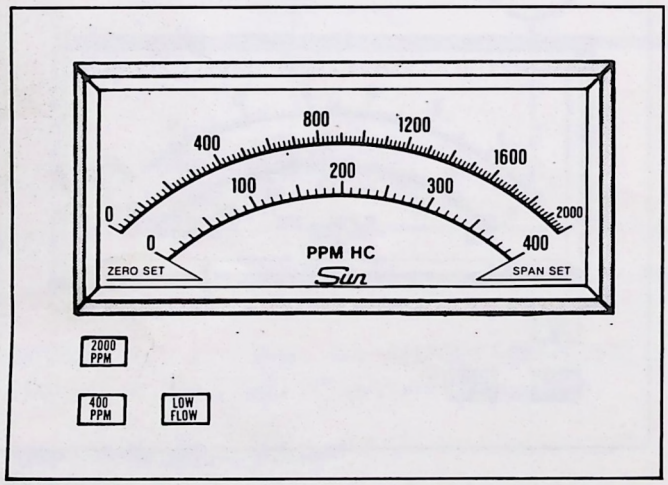


FIGURE 17 — PPM HC meter and indicator lights.

The VACUUM gauge dial does not have indicator lights (Figure 19). Either of the two scales can be read whenever vacuum is being tested. One is in inches and the other is in millimeters.

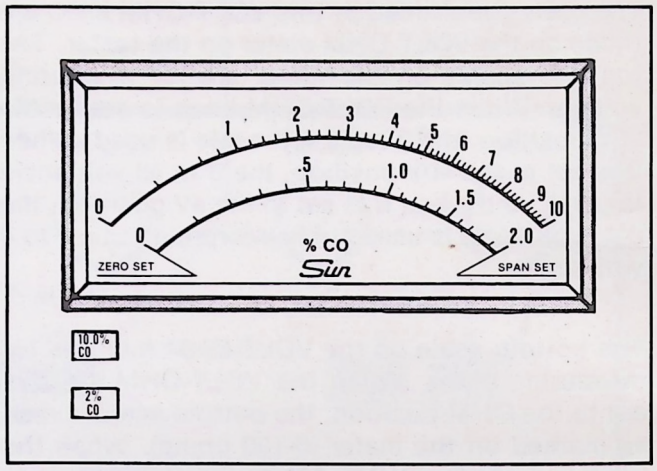


FIGURE 18 — Percent CO meter and indicator lights.

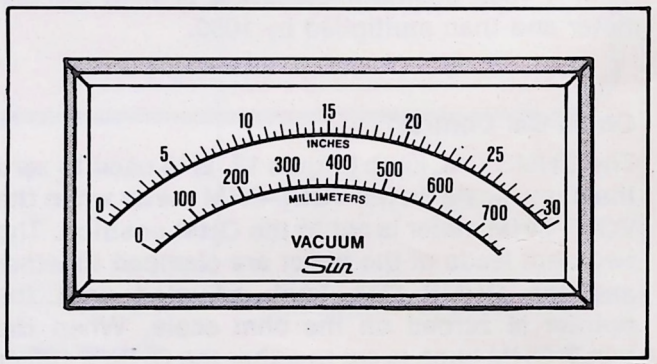


FIGURE 19 — VACUUM gauge meter.

Low Flow Indication

The LOW FLOW indicator below the PPM HC Meter (Figure 17) is illuminated in Yellow when the exhaust gas sampling system becomes restricted because of clogged filters, kinked pickup hose, etc. The LOW FLOW light is a warning that the Infra-Red system needs maintenance.

AREA TESTING PROCEDURES

AREA TESTING PROCEDURES

The factual information obtained from a systematized series of tests, when compared with specifications and known standards, provides an accurate picture of an engine's conditions. This series of tests to determine the true condition of the engine by testing the engine system is called area testing. When the true condition of the engine is determined the technician has little trouble knowing what service or what further detailed testing to perform.

TESTER PREPARATION

1. Plug tester POWER CORD into proper AC outlet (see nameplate on tester).

2. Turn AC POWER SWITCH (left end panel) to UNIT ON position. Sign, Meters and Scale Indicators will light and a trace will appear on the scope screen.

3. Place GAS CALIBRATE switch at rear of tester in OPERATE position.

4. Depress ZERO mode control button of INFRA-RED TEST SELECTOR to allow exhaust analyzer to warm while tester is being prepared.

POSITION SCOPE CONTROLS

1. Push PATTERN POSITION CONV (CONVENTIONAL) button.

2. Adjust BRIGHTNESS control as desired.

3. Adjust VERTICAL control so that scope trace line rests on scope zero line.

4. Adjust HORIZONTAL control to align the left end of the scope trace with the left edge (0-25 KV line) of the scope screen.

5. Adjust the LENGTH control to align the right end of the scope trace with the right edge (0-50 KV line) of the scope screen.

   NOTE: To adjust LENGTH control, the NO. OF CYLINDERS knob must be set to 8 or engine must be running.

6. Set FUNCTION SELECTOR knob to SECONDARY.

7. Set PATTERN HEIGHT knob to HIGH.

8. Set PATTERN SELECTOR knob to DISPLAY.

   NOTE: The RASTER control is not adjusted at this time. Adjust RASTER when necessary during testing.

POSITION TESTER CONTROLS

1. Push CYLINDER SELECT MODE SHORT button.

2. Set ENGINE KILL button to GREEN. (Green is the Run position. Red means ignition is disabled and engine will not run.)

3. Push CYLINDER SELECTOR Red CANCEL button.

4. Push the 4 CYCLE button for most automotive engines except the Rotary engine and any others having 2 cycle ignition.

5. Set the AMPERES-DWELL-RPM knob to AUTO-TACH/100A position and zero ammeter with the AMPS CAL knob. Then set AMPERES-DWELL-RPM knob to AUTO-TACH/500A position.

6. Set the IGNITION SELECTOR knob to #1 position except as follows:

   a. Delco HEI and Prestolite BID systems, set to #2 position.

b. Capacitive Discharge (CD) systems, set to #4 position.

7. Set NO. OF CYLINDERS knob to match the number of cylinders in engine being tested.

8. Set VOLT-OHM knob to 20V position.

CALIBRATE HC AND CO METERS

1. Allow depressed zero mode control button to remain depressed for 5 minutes to warm up tester.

2. Depress PPM HC 400 and % CO 2.0 buttons.

3. Adjust Zero knobs below meters until both meter pointers read ZERO SET.

4. Depress and hold SPAN mode control button while adjusting SPAN knobs below meters until both meter pointers read SPAN SET

5. Release SPAN button and recheck ZERO adjustment.

6. Push TEST button on INFRA-RED TEST SELECTOR.

NOTE: During first 15 minutes of operation, tester may require slight additional calibration adjustments. Calibration can be checked at any time by repeating steps above. It is not necessary to remove sample probe from tail pipe or to stop vehicle engine to recheck calibration of tester.

LEAD CONNECTIONS TO VEHICLE

(Negative ground systems shown) See Figure 20.

1. Clamp Chrome PATTERN PICKUP around the secondary coil wire. (On G.M. HEI Systems, with ignition coil in distributor cap, use Sun HEI Adapter #1747-102.)

   a. Connect Red PRIMARY PICKUP to the negative terminal of the ignition coil (on electronic and transistor ignition, to the specified terminal).

   b. Connect Black (Ground) PRIMARY PICKUP to a **good** engine ground.

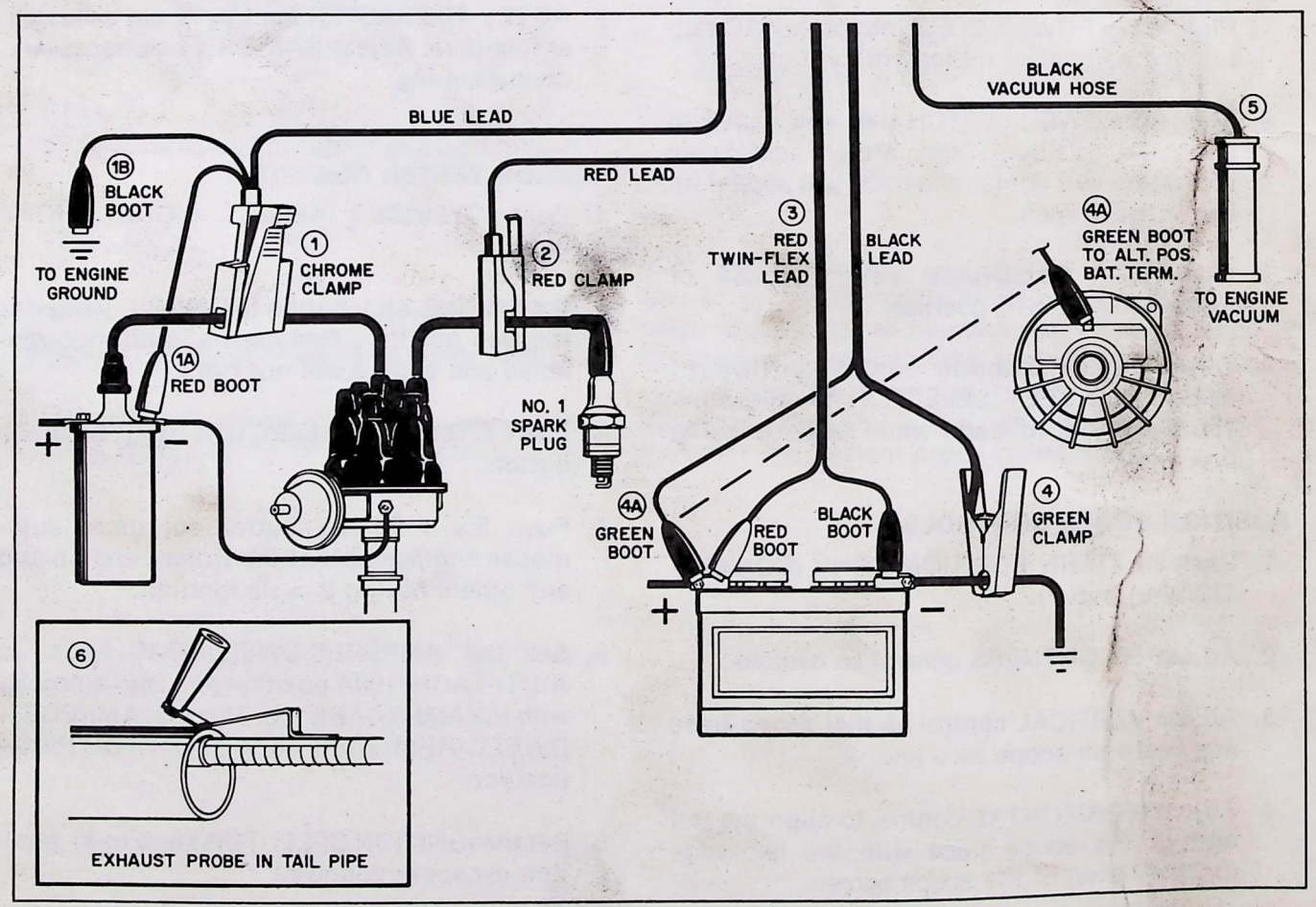


FIGURE 20 — Test lead connections to engine.

2. Clamp Red TRIGGER PICKUP around number 1 spark plug wire close to the distributor cap.

3. Connect VOLT-OHM leads to battery posts, Red to positive and Black to negative.

4. Clamp Green AMMETER PICKUP around negative battery cable (all negative cables if there are more than one) with arrow pointing away from the battery.

   a. Connect Green SPECIAL PATTERNS PICKUP to the positive (+) battery post.

   NOTE: If accessible, the alternator output (+) terminal can be used.

5. Connect VACUUM HOSE to a source of engine vacuum.

6. Insert EMISSION SAMPLING PROBE into vehicle tail pipe.

TESTING PROCEDURE

For best results use the SUN 1115 Engine Performance Test Report. Enter specifications, perform specified tests and enter test results for evaluation when finished with each test.

Test 1 — Cranking Tests

1. Disable the ignition system by disconnecting secondary coil wire from distributor cap; position end clear of ground. (To disable all HEI ignition systems, push ENGINE KILL button so it shows Red.) Turn off all lights and accessories.

2. Crank engine while reading the indications on the tester instruments.

   a. Note Cranking Coil Output in kilovolts on 50 KV scale of scope.

   NOTE: This test void when using ENGINE KILL BUTTON.

   b. Read Cranking Starter Current on Blue 500 amp scale of ammeter.

   c. Read Cranking Battery Voltage on Red 20 volt scale of voltmeter.

   d. Read Cranking Engine Vacuum on vacuum gauge.

Test 2 — Charging Tests

1. Turn AMPERES-DWELL-RPM knob to AUTO-TACH/100A scale.

2. Set FUNCTION SELECTOR knob to SPECIAL PATTERNS.

3. Set PATTERN HEIGHT knob to VARIABLE, and set VARIABLE ADJUST to full clockwise.

4. Set PATTERN SELECTOR knob to RASTER.

5. Prepare engine to run. Enable ignition system or release ENGINE KILL button to Green.

6. Start engine, accelerate to 2000 rpm.

   a. Note alternator output on Blue 100 amp scale of ammeter.

   b. Note condition of diodes/stator as indicated by scope patterns.

   (Use RASTER control if necessary to space scope patterns for best viewing.)

7. Return engine to idle speed.

Test 3 — Idle Tests

1. Turn AMPERES-DWELL-RPM knob to AUTO-TACH/DWELL.

2. Set FUNCTION SELECTOR knob to SECONDARY.

3. Set PATTERN HEIGHT knob to HIGH.

4. Set PATTERN SELECTOR knob to DISPLAY.

5. Warm up engine until choke is open and engine is at normal idle speed.

   a. Read Idle rpm on Red 0-1500 rpm scale of tachometer.

   b. Read Dwell on Red dwell meter scale.

   c. Check Initial Timing with timing light as specified for engine being tested.

   d. Read Carbon Monoxide percentage on CO Meter.

   e. Read Hydrocarbons PPM on HC meter.

   f. Read Engine Manifold Vacuum on vacuum gauge.

g. Test PCV valve per manufacturer's recommended procedure.

Test 4 — 1200 RPM Low Cruise

NOTE: Refer to the General Information section for examples of the various scope patterns.

1. Run engine at approximately 1200 rpm and perform scope tests.

   a. Coil polarity in DISPLAY.

   b. Spark Plug Firing Voltage (KV) in DISPLAY.

   c. Maximum Coil Output (available voltage) in DISPLAY.

   d. Secondary Insulation in DISPLAY.

   e. Secondary Resistance in RASTER.

   f. Coil and Condenser Condition in RASTER.

   g. Breaker Point Condition in RASTER.

   NOTE: Static point resistance test can also be made to check Breaker Point Condition.

   h. Cylinder Timing Accuracy in SUPERIMPOSE.

   i. Read Carbon Monoxide percentage on CO meter.

   j. Read Hydrocarbons PPM on HC meter.

   k. Push ZERO button on INFRA-RED TEST SELECTOR.

Test 5 — Cylinder Power Balance

1. Set PATTERN SELECTOR knob to DISPLAY.
2. Run engine at desired test speed — record base rpm.
3. Press CYLINDER SELECTOR button one at a time until all cylinders have been shorted and released one at a time.
4. Note and record rpm produced with each cylinder shorted.

Test 6 — Snap Acceleration

1. Push TEST button on INFRA-RED TEST SELECTOR.
2. Quickly snap accelerate engine and release throttle while observing spark plug firing lines on scope.
3. Note cylinders having firing lines too high or too low.
4. Snap accelerate the engine again and return to idle speed. Wait a few moments for CO reading to peak on the meter. Record maximum % CO.

Test 7 — 2500 RPM High Cruise

1. Set engine speed to approximately 2500 rpm.
2. Check timing advance with timing light following manufacturer's recommended procedure.
3. Read dwell in degrees on dwell meter.
4. Read Charging Volts on 20V scale of voltmeter.
5. Read Carbon Monoxide percentage on CO meter.
6. Read Hydrocarbons PPM on HC meter.
7. Read engine manifold vacuum on vacuum gauge.
8. Stop engine.
9. Push ZERO button on INFRA-RED TEST SELECTOR.

Analyze tests results, compare with specifications and perform pinpoint tests or make service recommendations as required.

ENGINE PERFORMANCE ANALYSIS GUIDE

AREA PERFORMANCE TEST ANALYSIS

Analyzing the results on the Engine Performance Test Report requires comparing the test results with manufacturer's specifications to determine which tests to mark NO-GO. Analyzing all of the tests marked NO-GO is the basis for determining what engine areas have problems, what specific Pinpoint Tests to perform, and what service recommendations to make.

The Sun Specification cards, underhood stickers and manufacturer's manuals and bulletins are used to obtain the specifications needed. Where no factory specifications are furnished, the technician must base his decision (GO or NO-GO) on what is normal for good engines of the make and model being tested based on past experience.

The following Analysis Guide lists the GO and NO-GO considerations and shows the most common Test Indications and the Action Required for each NO-GO Test Result.

ANALYSIS GUIDE

1. CRANKING MODE

COIL OUTPUT

GO — Height of scope pattern reaches or exceeds specified minimum.

NO-GO — Scope pattern height is below minimum.

Test Indications:

a. Battery voltage low.
   See Cranking Battery Voltage test result on Test Report.

b. Dwell too low.
   See result of dwell test in Idle Mode.

c. Bypass circuit bad.
   Test bypass circuit with voltmeter.

d. Low primary ignition current.
   Check with ammeter. Check for resistance in primary circuit and points. Check for possibility of wrong coil.

e. Coil or condenser bad.
   Test with Sun coil and condenser testers.

f. Bad coil wire to distributor cap.
   Test with ohmmeter.

NOTE: On electronic ignition, follow specified test procedure.

STARTER CURRENT

GO — Starter Current draw is not more than specified maximum.

NO-GO — Starter current draw is too high.

Test Indications:

a. Battery discharged, defective, or too small for application.
   Make complete battery test.
   Check battery rating with specifications.

b. Battery cables, starter solenoid or starter motor bad.
   Make complete starting system test.

c. Tight or hot engine.
   Cool off and retest.

BATTERY VOLTAGE

Go — Cranking battery voltage is at or above specified minimum.

NO-GO — Voltage is below specified minimum.

Test Indications:

a. Same test indications as Starter Current.

ENGINE VACUUM

GO — Vacuum reading steady at normal level.

NO-GO — Vacuum reading uneven or much lower than normal.

Test Indications:

a. Vacuum leaks.

(1) Examine all vacuum hoses including emission controls and accessories.

(2) Tighten engine manifold bolts, carburetor mounting bolts, etc.

b. Engine mechanical condition.

Test with cylinder leakage tester and compression tester.

2. CHARGING MODE

CHARGING SYSTEM

GO — Ammeter reading shows alternator is charging at least half of rated output, and alternator waveform on scope is normal.

NO-GO — Ammeter shows low output or no charge or alternator waveform on scope is abnormal.

NOTE: In most cases, when the alternator output is checked after making cranking tests, the ammeter reading seen at the instant the engine is started and "revved up" will be well over half of rated output. However, the condition of the battery, the length of time the engine was cranked and the speed the engine reached all can affect this reading.

Test Indications:

a. Fan belt loose or worn out.

Check and correct as necessary.

b. Accessory load very high.

Check current draw with key on. Add this reading to output obtained. Compare to specifications.

c. Alternator defective.

Check alternator output with amps pick-up at alternator and all accessories on.

d. Voltage regulator defective.

Use Starting and Charging System tester, bypass regulator and check alternator output.

DIODE STATOR

GO — Scope shows even ripple.

NO-GO — Scope shows uneven ripple.

Test Indications:

a. Output diodes or stator bad.

Remove and disassemble alternator and test components.

3. IDLE MODE

REVOLUTIONS PER MINUTE (RPM)

GO — Meets manufacturer's specified idle speed at specified test condition.

NO-GO — Idle speed not set to specifications.

Test Indications:

a. Carburetor idle speed and/or mixture screws not properly adjusted.

Correct as necessary.

b. Choke sticking or not fully open.

Correct as necessary.

c. Idle solenoid not adjusted correctly, if so equipped.

Correct as necessary.

d. Test not made under specified conditions. See specifications and under hood sticker.

Test as specified.

e. Mechanical Engine Condition.

Check all test results for indications of problems like fouled plugs, weak cylinders, etc.

f. Bad emission control devices, especially EGR valve.

Test and service per factory recommendations.

DWELL

GO — Dwell is within specifications.

NO-GO — Dwell is too high or too low.

Test Indications:

a. Ignition points improperly adjusted.
Reset to spec.

b. Distributor defective.
Make complete distributor test in Sun Distributor Tester.

NOTE: On electronic ignition, see manufacturer's recommendations.

INITIAL TIMING

GO — Timing set to specifications.

NO-GO — Timing is too early or too late.

Test Indications:

a. Timing not adjusted properly.
Reset to specifications.

b. Distributor advance mechanism bad.
Remove and test distributor on Sun Distributor Tester.

c. Engine not running at proper speed.
Vacuum retard not disconnected during test, if so specified.

NOTE: Timing must be adjusted according to specified procedure at specified rpm after dwell is set correctly.

CARBON MONOXIDE AT IDLE

GO — CO readings within specifications.

NO-GO — CO readings out of specifications.

Test Indications:

a. Carburetor settings incorrect.
Correct as necessary.

b. Wrong float adjustment.
Adjust as necessary.

c. Dirty air cleaner.
Clear or replace element.

d. Improper idle speed.
Adjust as necessary.

e. Oil in crankcase diluted with gasoline or excessive engine blow-by.
Correct as necessary.

HYDROCARBON AT IDLE

GO — HC within specifications.

NO-GO — HC readings out of specifications.

Test Indications:

a. Engine mechanical problems indicated.
Service and repair as necessary.

b. Ignition problems indicated.
Test and service ignition system.

ENGINE VACUUM

GO — Steady at or above specified minimum.

NO-GO — Unsteady or below specified minimum.

Test Indications:

a. Same test indications as for cranking engine vacuum.

POSITIVE CRANKCASE VENTILATION (PCV)

GO — Engine rpm, CO or vacuum changes as specified when PCV is plugged.

NO-GO — RPM, CO or vacuum does not change when PCV is plugged.

Test Indications:

a. PCV valve is plugged or defective.
Clean or replace and retest.

b. PCV hose or vacuum source is plugged or hose is cracked.
Repair as needed.

c. Wrong PCV valve.
Replace with correct one.

4. 1200 RPM LOW CRUISE MODE

COIL POLARITY

GO — Pattern right side up.

NO-GO — Pattern inverted (firing lines extend downward).

Test Indications:

a. Ignition coil primary wires reversed. (Should match battery ground polarity.)
Check and correct as necessary.
Make sure coil is correct one.

b. Battery installed backwards or charged backwards.

Check with voltmeter.

Correct as required.

SPARK PLUGS

GO — Firing voltages even within 3 KV and normal for engine being tested.

NO-GO — Firing voltages vary more than 3 KV. All firing lines excessively high or excessively low.

Test Indications:

a. Spark plug or rotor gaps not correct.

Bad resistor spark plugs. Rotor, distributor or wires defective.

Use grounding probe to pinpoint cause of high readings, visual inspection for narrow plug or rotor gaps.

b. Fuel mixture incorrect.

Check choke and carburetor adjustment.

Check for vacuum leaks.

c. Timing or advance incorrect.

See Initial Timing test results in Idle Mode, Timing Advance test results in High Cruise Mode.

d. Electronic distributor trigger coil connected wrong.

Reverse connections and retest.

MAXIMUM COIL OUTPUT

GO — Reaches or exceeds specified minimum.

NO-GO — Output is less than minimum specified.

Test Indications:

a. Dwell too low.

See Dwell Test Results in Idle Mode and High Cruise Mode.

b. Excessive resistance in ignition switch, primary circuit or points.

Check with voltmeter, ohmmeter.

c. Low voltage due to charging system problem.

See Charging Volts Test Result in High Cruise mode.

d. Insulation bad in secondary circuit.

If coil output is under 25 KV and lower extent of waveform is intermittent or missing, test for insulation breakdown in wires, cap, or rotor.

e. Coil or Condenser defective.

Test and replace as needed.

SECONDARY INSULATION

GO — Lower extent of coil waveform (down-spike) is steady and equal to about one half of upward extent.

NOTE: This does not apply to high output systems such as HEI that produce over 30 KV since the spark will jump inside the distributor cap on good systems.

NO-GO — Coil output is less than 25 KV and the down-spike is intermittent or missing.

Test Indications:

a. Wires, cap, rotor, or coil bad.

Make secondary insulation test of all cylinders to isolate problem.

SECONDARY RESISTANCE

GO — Length and slope of spark lines is normal for engine being tested.

NO-GO — One or more spark lines slants excessively and is too short.

Test Indications:

a. Excessive resistance in plugs, wires, rotor, or distributor cap, or coil tower.

Isolate problem using grounding probe.

COIL-CONDENSER

GO — Normal number and size of oscillations in intermediate section.

NO-GO — Oscillations diminished or missing in intermediate section.

Test Indications:

a. Coil or condenser defective.

Test and replace as necessary.

b. Points, condenser, or ground pigtail loose in distributor.

Make complete distributor test.

NOTE: Some ignition systems such as Chrysler Electronic Ignition will not show oscillations.

BREAKER POINTS

GO — Point close and point open signal normal.

NO-GO — Point close or point open signal irregular or show arcing.

Test Indications:

a. Dirty, burned, or misaligned points.
Replace points, test condenser.

b. Weak point spring tension.
Replace points, adjust spring tension.

c. Dwell too high or primary current too high.
Check dwell, measure primary current, correct as necessary.

d. Wrong coil or ballast resistor.
Check and correct as needed.

e. Charging voltage incorrect.
See Test Result in High Cruise Mode.

CYLINDER TIMING

GO — Point open signals even within specifications.

NO-GO — Point open signals vary more than specified (usually ±2°).

Test Indications:

a. Distributor cam defective.
Remove and test distributor in Sun Distributor Tester.

b. Breaker plate or bushings worn or defective. Wrong point spring tension. Remove and test distributor in Distributor Tester.

c. Problem in engine such as bad distributor bushing in block or loose timing chain.
Check and repair as needed.

CARBON MONOXIDE AT LOW CRUISE

GO — CO readings within specifications or slightly less than idle CO.

NO-GO — CO readings out of specifications.

Test Indications:

Same as for Idle CO.

HYDROCARBON AT LOW CRUISE

GO — HC reading within specifications.

NO-GO — HC readings out of specifications.

Test Indications:

Same as for Idle HC.

5. CYLINDER POWER BALANCE MODE

GO — RPM with each cylinder shorted dropped approximately the same amount.

NOTE: Amount of drop and allowable variation depends upon type of engine, number of cylinders, and speed at which test was made.

NO-GO — RPM does not change or changes very little on one or more cylinders.

Test Indications:

a. Ignition problems.
Check results of scope tests in Low Cruise Mode.

b. Engine problems.
Check compression and cylinder leakage.

c. Fuel mixture or distribution problems.
Check for vacuum leaks.
Check carburetor adjustment and balance.

6. SNAP ACCELERATION MODE

PLUGS UNDER LOAD

GO — Firing lines increase moderately and evenly and firing voltages does not exceed maximum specified.

NO-GO — Firing lines do not increase evenly or firing voltages exceed maximum specified.

Test Indications:

a. Spark plugs worn out, gapped wrong, or are fouling out.
Clean and regap or replace as required.

b. Lean fuel mixtures.
Check carburetor accelerator pump and high speed circuit.

7. 2500 RPM HIGH CRUISE MODE

TIMING ADVANCE

GO — Timing is advanced specified amount.

NO-GO — Timing advance too little or too much.

Test Indications:

NOTE: These tests can be done with a Distributor Tester.

a. Vacuum advance chamber is leaking or inoperative.
   (1) Check vacuum chamber with external vacuum source.
   (2) If vehicle is equipped with transmission controlled spark, recheck advance as specified for this type of system.
   (3) Check vacuum supply to distributor advance unit.

b. Mechanical advance sticking or inoperative.
   Disconnect vacuum advance and repeat advance test.
   This checks mechanical advance only.
   Remove and repair distributor.

c. Wrong distributor for engine.
   See specifications.

DWELL

GO — Dwell reading does not change more than specified from dwell at idle.

NO-GO — Dwell reading changed more than allowable for system being tested.

NOTE: Some electronic ignition systems incorporate a dwell change in the design. See specifications and recommendations for system being tested.

Test Indications:

a. Distributor in poor mechanical condition.
   Remove and test in distributor tester.
   Repair as needed.

CHARGING VOLTS

GO — Voltmeter reading within specifications.

NO-GO — Voltage higher or lower than specified.

Test Indications:

a. Make complete charging system test with Starting and Charging system tester.

CARBON MONOXIDE

GO — CO reading within specifications and less than at idle.

NO-GO — CO reading not within specifications.

Test Indications:

a. Plugged air bleeds or restricted air cleaner.
   Unplug and/or replace.

b. Incorrect metering rod adjustment or incorrect metering jets.
   Adjust or replace as required.

c. Leaky power valve, accelerator pump or check valve.
   Correct as necessary.

d. High float level.
   Adjust as required.

HYDROCARBON

GO — HC reading within specifications.

NO-GO — HC reading not within specification.

Test Indications:

a. Plugged high speed passages or jets.
   Unplug as required.

b. Incorrect metering jets or metering rod adjustment.
   Adjust or replace as needed.

c. Manifold or carburetor air leaks.
   Service as necessary.

d. Low float level.
   Adjust as required.

e. Ignition system problem.
   Test and service as necessary.

ENGINE VACUUM

GO — Reading steady and higher than at idle.

NO-GO — Vacuum unsteady or lower than at idle.

Test Indications:

a. Engine problems.
   Check cylinder power balance test results.

b. Exhaust system restricted.

c. Timing not advancing properly.
   Check results of timing advance test.

METER AND GAUGE TESTING

RPM X 100 TACHOMETER

NOTE: Testing procedures for the meters and gauges are presented in this section. For a complete presentation of automotive testing, which includes meter and gauge testing, refer to Sun's Automotive Testing And Diagnosis manual.

Revolutions per minute (rpm) can be measured from 0 to 12000 rpm. With the AMPERES-DWELL-RPM knob in the AUTO-TACH/DWELL position, the Red 0-1500 and the Blue 0-6000 scales are activated. Engine speed determines which scale applies and which indicator lamp is lit. When engine rpm is in the 0-1500 range, the 1500 RPM indicator lamp will light. When engine rpm is in the 0-6000 range, the 6000 RPM indicator lamp will light. With the AMPERES-DWELL-RPM knob in the 12000 RPM/DWELL position, only the Blue 0-12000 scale and the 0-12000 RPM indicator lamp are activated.

TEST CONNECTIONS

1. Clamp the Red TRIGGER PICKUP onto the wire lead of the timing spark plug (normally No. 1 in the firing order).

2. Set NO. OF CYLINDER control to match the number of cylinders of engine being tested.

3. Push CYCLE button 2 or 4 to match the type of ignition system being tested.

Tachometer readings can be obtained from the primary as well, by connecting the Red Boot of the Blue lead to the distributor side of the coil, and the Black Boot to ground.

CYLINDER POWER BALANCE TEST

The power balance test provides a means of shorting out cylinders individually or in combinations to determine how well the engine runs with the remaining cylinders. This test compares the change in engine rpm with one cylinder at a time or with similar groups of cylinders shorted. The test results indicate whether or not any cylinder or combination of cylinders is developing its share of drive power.

The less power produced by a given cylinder, the less rpm will be lost when that cylinder is shorted out.

Shorting in Pairs

Shorting in pairs is primarily used on 4-cylinder engines.

1. Start engine and operate at approximately 1000 rpm. (If attempting to troubleshoot a specific performance problem, operate engine at speed where problem is most noticeable.)

2. Push CANCEL button of the CYLINDER SELECTOR controls.

3. Push 1 and 3 buttons of CYLINDER SELECTOR controls. Then push the CYLINDER SELECT MODE SHORT button.

   NOTE: The operator has 20 seconds to record a data reading. The SHORT button should be cancelled after approximately 20 seconds.

4. Note and record rpm with cylinders shorted.

5. Perform Steps 2, 3, and 4 with buttons 2 and 4 depressed.

6. Push the CANCEL button. Allow engine base speed to stabilize, and then record engine base speed.

   NOTE: The individual rpm readings must be subtracted from the base rpm to find the change in rpm. The weak cylinders are those

with the least amount of change in rpm when they are shorted out.

7. Record and evaluate the test data.

Shorting In Combinations

This test is applicable on engines with any number of cylinders.

CAUTION: On cars with catalytic converters, consult manufacturer's instructions telling how many cylinders can be safely shorted out at one time.

The method of doing the power balance test is given under the heading, Shorting In Pairs. Other tests can be devised for shorting other combinations of cylinders, but the test procedure must conform to the test steps under Shorting In Pairs.

When testing with odd or even cylinders shorted, for example, follow the procedure under Shorting In Pairs, except short the odd numbered cylinders first and get an rpm reading. Then, short the even numbered cylinders and get an rpm reading.

Compare the engine rpm results to see if the two groups of cylinders are balanced.

The combinations of cylinders that can be shorted are many and varied. The operator can create many test combinations to fit his testing needs, provided he follows the method of operating the tester as demonstrated under Shorting In Pairs.

CARBURETOR POWER BALANCE TEST

This test procedure works well on most standard production V-8 engines. However, there may be some high performance engines or special intake manifolds that follow a different fuel distribution pattern.

1. Identify each engine cylinder by number on an engine chart. Cylinder numbers are identified on Sun Specification Cards and in manufacturer's engine service manuals.

NOTE: The cylinders may be numbered like many American Motors, Chrysler and General Motors engines (Figure 21). One, three, five and seven are in the left bank, and two, four, six and eight are in the right bank, and fire in in the sequence of 1, 8, 4, 3, 6, 5, 7, 2. By writing the firing order in the space provided below the Power Balance buttons, it can be readily seen that depressing the odd numbered buttons will short out the four cylinders (1, 4, 6 and 7) being fed from the left barrel of the carburetor (Figure 22). On the other hand, if the even numbered buttons are depressed, the cylinders fed by the right barrel (2, 3, 5 and 8) will be shorted out.

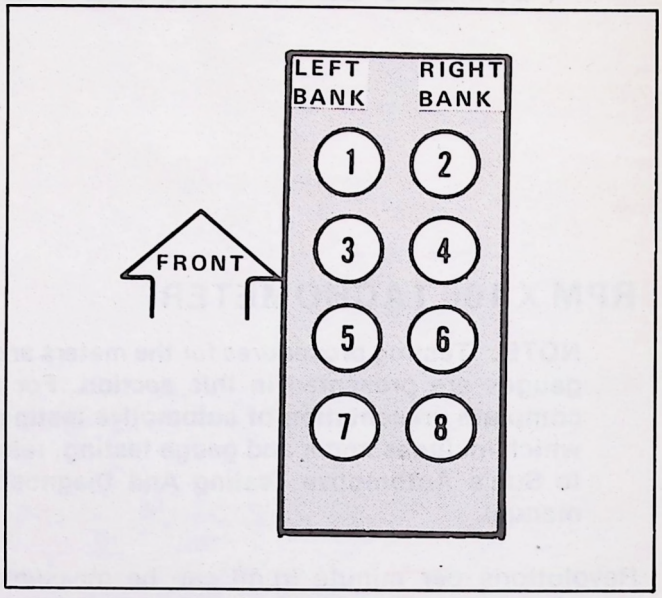


FIGURE 21 — One method used in numbering cylinders.

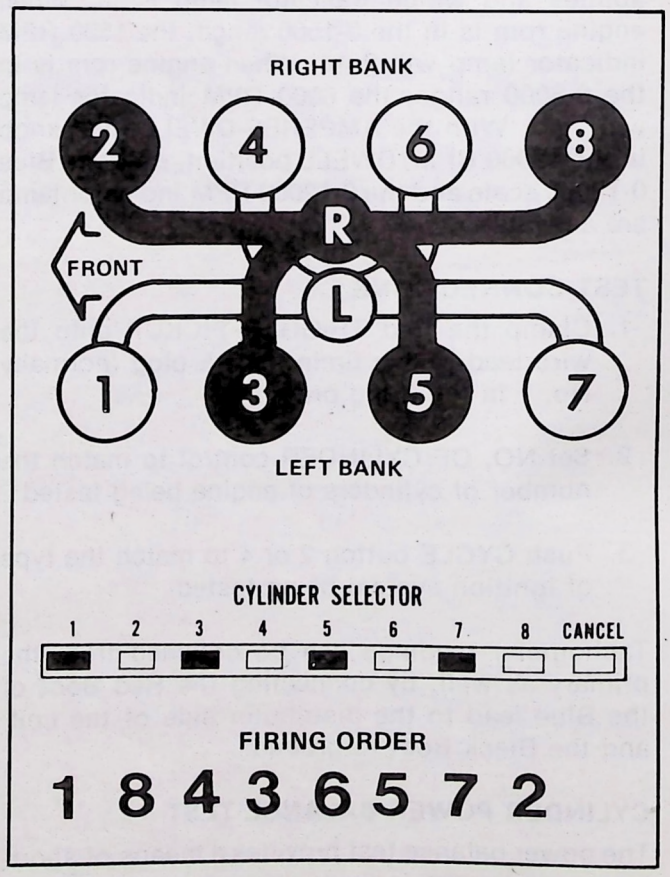


FIGURE 22 — The cylinders fed by the left and right carburetor barrels related to the cylinder power balance buttons and the firing order of one engine.

2. Turn the engine at test speed.

3. Short out the "even" half of the cylinders and note the engine rpm. The Power Balance function of the tester is used for this test. The Power Balance Test has been explained previously.

   CAUTION: On vehicles equipped with catalytic converters, do not run for more than 20 seconds at a time with four cylinders shorted.

4. Short out the "odd" half of the cylinders and note the engine rpm.

5. Compare these engine speeds and adjust carburetor as required.

   NOTE: Be sure engine is mechanically sound. An unsound engine will give erroneous readings on the Carburetor Balance Test.

   Testing for mechanical soundness of engines is as follows:

   1. Short out 4 cylinders (one bank on GM 1, 3, 5 & 7).
      Note RPM reading.

   2. Short out other bank (2 4 6 & 8). Note RPM reading. RPM should be even within 10 rpm in order to achieve good carburetor balance.

IDLE SPEED

Follow manufacturer's procedure for setting engine idle speed. The type of engine, transmission and accessories installed will frequently determine the correct idle speed.

1. With tester connected, start engine and run until it is at normal operating temperature (choke open).

2. Place transmission and accessories in the operating condition indicated by manufacturer's specifications for Idle Speed Test (for example: Automatic Transmission in Drive, Air Conditioning ON).

3. Observe Engine rpm and compare with manufacturer's specifications for Idle Speed.

POSITIVE CRANKCASE VENTILATION TEST

A test of the PCV system can be conducted by closing off the system at a point prior to its connection by the intake manifold and noting the change in engine rpm.

1. Place at idle rpm and normal operating temperature (choke fully open).

2. Close off or plug the PCV hose to the intake manifold.

3. Observe the tachometer for change in engine speed.

   a. Engine speed decreases by 50 rpm or more (unless otherwise specified by manufacturer) — indicates PCV operation normal.

   b. Engine speed does not change — indicates PCV valve, hoses, or air intake clogged.

   NOTE: See other PCV tests, such as Vacuum and CO tests.

DWELL-AMPS METER

The DWELL-AMPS meter is used to measure dwell, current and distributor resistance. With the AMPERES-DWELL-RPM knob in the AUTO-TACH/DWELL or the 12000 RPM/DWELL position, the Red Dwell scale is activated. The Dwell Meter measures and registers the average dwell for all cylinders in terms of degrees of distributor cam rotation.

DWELL TEST CONNECTIONS

1. Connect and prepare the Tachometer as outlined in RPM x 100 Tachometer Section.

2. Connect Red primary pickup lead to the coil primary terminal on the distributor.

3. Connect the Black primary pickup lead to engine ground.

Dwell Test

1. Operate engine at idle speed.

2. Observe the indication on the Red Dwell Meter scale. Compare with manufacturer's specifications.

Dwell Variation
(Contact Controlled Systems Only)

Dwell variation is determined by noting any dwell change as the engine is operated at different speeds. Excessive variation indicates a change in point opening that can result from shaft or bushing wear, or from the distributor plate shifting because of wear or looseness. In some cases

(Chrysler and Ford) a 5° dwell variation may be normal.

1. Measure distributor dwell at idle speed.

2. Increase speed to 2500 rpm.

3. Note dwell reading at 2500 rpm; then slowly reduce speed to idle while watching Red Dwell scale. Dwell reading should not change more than 3 degrees with distributor vacuum lines disconnected and plugged.

Compare with manufacturer's specifications.

Distributor Resistance

Distributor resistance tests are made to determine the primary circuit resistance from the negative terminal of the coil through the distributor to engine ground.

1. Place the AMPERES-DWELL-RPM knob in the DIST RES position.

2. Crank engine until distributor contact points are closed.

3. With the ignition switch on, observe the Red Dwell scale.

   The resistance is normal if the pointer stays within the Black DIST RES portion of the scale.

AMPS TEST PROCEDURE

1. Clamp the Ammeter probe around one wire of of the circuit to be tested with the arrow on the probe pointing in the direction of expected current flow.

2. Read circuit amperage on appropriate Blue AMPS scale. If the ampere meter pointer goes above the top of the AUTO-TACH/100A scale, change the AMPERES-DWELL-RPM knob to the AUTO-TACH/500A position.

Alternator Output Test

1. Clamp the AMPS PICKUP around the alternator output wire with arrow pointing away from alternator.

2. Set the AMPERES-DWELL-RPM knob to AUTO-TACH/100A.

3. Start engine and run at approximately 1500 rpm.

4. Turn on headlights and all accessories.

5. Observe the Blue AMPS scale for alternator output indication.

   Testing in this manner will usually cause the alternator to charge within specification. However, it is possible that if the accessory load is not great enough, the output seen may not be maximum. If there is any question concerning the condition of the alternator, test with a Volts-Ampere Tester that has an adjustable load.

VOLT-OHM METER

The VOLT-OHM meter is used to measure voltage and resistance. The Voltmeter indicates the difference in electrical pressure in volts between any two points in a circuit. The ohmmeter indicates the resistance in ohms between any two points in a circuit.

CRANKING VOLTAGE TEST

1. Connect the VOLT-OHM leads to the battery posts, Red to positive and Black to negative.

2. Turn VOLT-OHM knob to the 20V position for 6 and 12 volt systems and 40V position for 24 volt systems.

3. Disable ignition system by disconnecting the secondary coil wire from the distributor cap or use ENGINE KILL button on tester.

4. Crank engine.

5. Observe cranking voltage, cranking speed and evenness of cranking. Indication should be even and within manufacturer's specifications.

CHARGING VOLTAGE TEST

1. Turn VOLT-OHM knob to the 20V or 40V position depending on the vehicle's voltage.

2. Connect VOLT-OHM leads to the battery posts, Red to positive and Black to negative.

3. With the Tachometer connected as previously outlined, operate engine at a speed of 1500 to 2000 rpm.

4. Note Voltmeter reading after the meter pointer stops climbing. Indications should be within manufacturer's specification.

IGNITION PRIMARY AND BYPASS CIRCUIT TEST

1. Turn VOLT-OHM knob to 4V position.

2. Connect the VOLT-OHM leads, Red to the positive battery post and Black to the positive side of the ignition coil.

3. Ground the primary terminal of the distributor using a jumper wire.

4. With all lights and accessories turned off, crank engine and observe Voltmeter indication. Cranking voltage should be below 0.5 volt or that specified by the manufacturer.

OHMMETER CALIBRATION

The OHMS CAL knob is used to zero the ohm scale on the VOLT-OHM meter when the VOLT-OHM knob is set to the OHM position. When the VOLT-OHM knob is set to either the OHM x 100 or OHM x 1000 positions, the tester automatically sets the pointer to zero.

1. Set VOLT-OHM knob to OHM position.

2. With two ohm leads clamped together, turn OHMS CAL knob to the left or right as necessary until the meter pointer is set at zero.

COIL PRIMARY RESISTANCE TEST

1. Set VOLT-OHM knob to OHM position.

2. Connect VOLT-OHM leads, Red to one coil primary terminal and Black to the other coil primary terminal.

3. Observe Ohmmeter indication and compare with specifications.

COIL SECONDARY RESISTANCE TEST

1. Set VOLT-OHM knob to OHM x 1000 position.

2. Install a Pickup Extension in the tower of coil.

3. Connect VOLT-OHM leads, Red to coil negative or positive primary terminal and Black to the Pickup Extension.

4. Observe Blue Ohmmeter scale and compare with coil specifications.

COIL PRIMARY GROUND TEST

1. Connect VOLT-OHM leads, Red to coil negative or positive primary terminal and Black to the coil case.

2. Turn VOLT-OHM knob to OHM x 1000 position.

3. Blue Ohmmeter scale should show no pointer movement. Otherwise, a grounded primary winding is indicated.

SECONDARY IGNITION CIRCUIT RESISTANCE TEST

1. Place VOLT-OHM knob in the OHM x 1000 position.

2. Connect VOLT-OHM leads, Red to a Test Contactor and Black to an 18 inch jumper wire.

3. Remove distributor cap from the distributor and the spark plug wires from the spark plugs.

4. Connect 18 inch jumper wire (clip) to one of the distributor cap terminals.

5. Connect the Test Contactor to the spark plug end of the wire connected to this distributor cap terminal. Observe Blue Ohmmeter scale indication.

6. Repeat Steps 4 and 5 for each spark plug wire and the coil wire. Indications should be as specified by manufacturer.

ALTERNATOR ROTOR CIRCUIT RESISTANCE

1. Place VOLT-OHM knob in the OHM x 100 position.

2. Disconnect alternator field wire from alternator field terminal.

3. Using an appropriate adapter, connect VOLT-OHM leads one to alternator field terminal and the other to alternator or engine ground.

4. Observe Blue Ohmmeter scale for field circuit resistance. Indication should be within specifications.

VACUUM GAUGE

The vacuum gauge is used to measure pressure below atmospheric pressure. The scale ranges from 0 to 30 inches. In addition, a scale in millimeters (0-700 mm) is provided for comparison with international car specifications.

CRANKING VACUUM TEST

1. Connect vacuum gauge hose to a source of intake manifold vacuum. Use Tee adapter hoses as required.

2. Disable ignition by disconnecting secondary coil wire from distributor cap or use ENGINE KILL button.

3. Crank the engine and note the action of the Vacuum Gauge. If the vacuum is very low (less than 1"), it may be necessary to back out the idle speed control or disconnect the electrical throttle stop solenoid in order to increase the cranking vacuum to a higher, more readable level.

4. At the conclusion of the test, restore ignition system operation, and make sure all engine vacuum lines are reconnected properly and securely.

Normal engine condition will result in a steady vacuum that is even and has a rhythmic pulsation.

PCV VALVE TEST

This simple test quickly determines whether or not the PCV system is working properly.

1. Connect the VACUUM gauge lead and disable the ignition system as for the Cranking Vacuum test.

2. While cranking the engine, pinch the PCV hose or close the end of the PCV valve to prevent air from leaking into the intake manifold.

3. Watch the VACUUM gauge.

   An increase in vacuum with the PCV blocked, indicates the PCV system is open and capable of functioning.

4. Enable engine.

NOTE: Also see PCV Test with CO meter.

IDLE VACUUM TEST

Idle vacuum readings aid in determining the existence of any problems relating to compression leaks in the cylinders or intake manifold, leaking or sticky valves, improper timing or fuel mixture which may affect engine operation.

1. Connect VACUUM gauge as for cranking vacuum test.

2. Start engine and operate at specified idle rpm.

A steady vacuum reading between 15" and 22" indicates the engine is in good condition and operating normally.

EXHAUST RESTRICTION TEST

Any unusual restriction in the exhaust system will result in inefficient engine performance at higher than idle speeds. To determine whether restrictions exist, proceed as follows:

1. Connect the VACUUM gauge to the intake manifold in the usual manner.

2. Start engine, operate at idle rpm and note the vacuum reading.

3. Increase engine speed to approximately 2500 rpm and again note the vacuum reading.

An increase in vacuum over the vacuum obtained at idle indicates that the exhaust system is free of restrictions.

FUEL PUMP VACUUM TEST

The fuel pump vacuum test is an auxiliary test and is necessary only when the pump output does not meet the pressure or volume specifications. The fuel pump vacuum test is made to determine whether the defect is in the pump or in the fuel line.

1. Disconnect fuel pump flexible line from tank fuel delivery line.

2. Connect vacuum line from tester to fuel pump using adapter, if necessary.

3. Start engine and operate at idle speed.

4. Run engine for a period of time sufficient to permit VACUUM gauge to reach its maximum reading.

5. Stop engine and observe VACUUM gauge for ten or fifteen seconds.

If maximum vacuum is ten inches or more, and does not fall off when the engine is stopped, the pump valves are OK.

If maximum reading is less than 10 inches, or vacuum falls off rapidly, replace fuel pump.

PPM HC AND % CO METERS

Hydrocarbon (HC) is measured as N-Hexane in parts per million (PPM) and carbon monoxide (CO) is measured in percent (%). Hydrocarbons present in the exhaust system represent unburned gasoline. An increase in the level of HC emission is a direct result of mechanical engine condition, temperature and ignition. Just one spark plug not

firing will raise the HC emission by many times the normal reading in PPM. Carbon Monoxide is a by-product of fuel after it is burned in the combustion chamber. An overly-rich mixture will cause a high reading on the CO meter.

Exhaust gas samples are continuously picked up by means of a probe inserted in the vehicle's tail pipe and are conveyed to the exhaust gas analyzer by means of a hose. The Infra-Red analyzing device determines the exact amount of hydrocarbons and carbon monoxide contained in the sample. This data is then converted into electrical signals and read out on the respective meters.

Since governing bodies in several states and metropolitan localities have already set specifications limiting allowable exhaust emissions, the future trends can only be to still further lower the levels of emissions allowed. The Infra-Red exhaust analyzer has been designed and built not only to test present vehicles for compliance with established standards, but also to provide the scale ranges and accuracy necessary to test vehicles for compliance with the anticipated standards of the future.

Besides measuring emission levels to determine compliance with legal standards, you can perform emission tests at several speeds and under various conditions to quickly uncover a variety of engine, ignition and fuel system service requirements. This Infra-Red exhaust analyzer provides the accuracy and range for checking and adjusting carburetors, particularly on late model engines. It also serves as a valuable quality-control tool after tune-up, to aid in determining whether all work was performed properly.

CONNECTION, WARM-UP AND CALIBRATION

1. Mechanically set meters to ZERO line.

2. Depress TEST SELECTOR ZERO button and permit tester to operate for approximately 5 minutes.

3. Depress PPM HC 400 and % CO 2.0 buttons.

4. Depress and hold SPAN mode control button while adjusting SPAN knobs below meters until both meter pointers read SPAN SET.

5. Release SPAN button and recheck ZERO adjustment.

   NOTE: After initial warm-up and calibration, "Zero" and "Span" adjustments can be rechecked at any desired interval, even with the sample probe in the tail pipe of a running engine.

TESTING PROCEDURE

1. Depress the PPM HC 2000 button and the % CO 10 button.

2. Insert sampling probe approximately 12" into vehicle tail pipe.

   a. Be sure that the vehicle's exhaust system is air tight. Air leaking into the system could dilute the exhaust gas and affect the readings.

   b. When testing vehicles with dual exhaust, each side must be tested separately to insure that an exhaust sample from each bank of cylinders has been analyzed.

3. Depress TEST button of the INFRA-RED TEST SELECTOR.

4. Operate engine at desired test speed, and note and record readings of both meters (If HC meter reads less than 400 PPM and/or CO meter reads less than 2.0%, switch to low meter scales for more convenient meter readings by depressing the appropriate scale range button.)

5. If exhaust performance tests are to be conducted at more than one engine speed, readjust engine speed as necessary and repeat Step 4 above.

6. At the conclusion of the tests, depress the ZERO button of the INFRA-RED TEST SELECTOR.

7. Remove sample probe from the vehicle tail pipe.

   NOTE: Allowing the ZERO button to remain depressed during intervals between tests, the tester will be ready for use without further warmup and filter life will be extended. To turn tester completely off, depress the OFF button.

ENGINE PERFORMANCE TEST

Make tests with engine at normal operating temperature. Refer to manufacturer's specifications and local exhaust emission limits.

NOTE: When testing some electronic fuel injected vehicles without a load, only idle readings will be accurate. Testing of these

engines at 2500 RPM must be done on a dynamometer.

1. Measure HC and CO at 2500 RPM.
2. Measure HC and CO at idle RPM.
3. Compare readings with specifications.

   GOOD: HC and CO readings within specifications at idle and 2500 RPM.

   BAD: HC or CO readings exceed specifications at either idle or at 2500 RPM. Corrective service is required.

NOTE: Always refer to manufacturer's specifications when available. These specifications are usually found on a sticker under the hood. Otherwise, refer to Sun's Specification Cards.

COMMON CAUSES OF EXCESSIVE EMISSIONS

Higher than normal Hydrocarbon readings can be caused by any one or more of the following conditions:

- Improper ignition timing
- Ignition system malfunctions (misfire)
- Excessively rich or lean carburetor
- Engine problems — such as:
  - Low compression
  - Leaky gaskets
  - Defective valves, guides or lifters
  - Defective rings, pistons or cylinders
  - Incorrect thermostat

Higher than normal Carbon Monoxide readings can be caused by any one or more of the following conditions:

- Rich carburetor
- Dirty air cleaner
- Defective choke
- Improper idle speed

Higher than normal Hydrocarbon and Carbon Monoxide readings can be caused by any one or more of the following conditions:

- Inoperative PCV system
- Heat riser stuck open
- Air pump inoperative or disconnected
- Sticking air cleaner preheat door

To pinpoint specific compression and ignition system deficiencies, conduct detailed tests of these areas. After tune-up, recheck emission levels.

CARBURETOR ADJUST AND TESTING

Adjusting and testing carburetor operation with the Infra-Red Exhaust Performance Tester requires only that you remember how each thing you are changing should affect the air/fuel mixture. If you do something to enrich the air/fuel mixture, the CO level should increase. If you make the air/fuel mixture leaner the CO should decrease. If you make the mixture so lean that one or more cylinders misfire, then the HC level will increase.

Make all carburetor idle and mixture adjustments as per manufacturer's recommended procedure. Where the manufacturer gives a CO setting, use the Infra-red tester to make these adjustments. On vehicles where CO specifications are not available, use levels below state and local legal limits and normal for the year and make of vehicle being tested. If you are unable to attain the desired HC and LO level by following the manufacturer's adjustment procedures, there may be problems such as faulty ignition or compression. These areas should be thoroughly tested before condemning the carburetor.

IDLE ADJUSTMENT AFTER MAJOR CARBURETOR OVERHAUL OR REPAIR

1. Lightly seat idle mixture adjusting screws.
2. Back out each screw approximately 4 turns or to internal stops if so equipped.
3. Start engine and warm up to normal operating temperatures.
4. Calibrate the Infra-red tester, insert probe into tail pipe and depress TEST button.
5. Adjust engine idle speed to manufacturer's specifications.
6. Gradually adjust mixture screws equally to obtain the lowest HC reading and smoothest idle.
7. Readjust idle speed as necessary after each mixture adjustment to maintain specified idle RPM.
8. Gradually adjust idle mixture screws equally to obtain lowest CO reading without increasing the HC reading.
9. All readings should be taken with air cleaner

completely installed and at normal operating temperature.

10. HC and CO readings should now be within manufacturer's specification and/or legal limits with engine operating smoothly.

NOTE: If the idle adjustment process takes longer than two minutes, clean out engine by running it at approximately 2000 RPM for a few seconds.

PCV TEST

Follow this procedure to determine if the PCV system is functioning properly.

1. With engine running, note CO reading on CO Meter.

2. Remove PCV valve from the engine but do not remove it from the hose to the carburetor or intake manifold.

3. Observe CO reading on CO Meter. CO reading should drop to a lesser value than previously noted.

4. Plug the open end of the PCV valve, and read the CO Meter again. The reading should be a greater (richer) value than that taken in Step 3.

   No changes in CO reading indicates the PCV system is not functioning. Clean or replace valve and hoses as necessary and retest.

Accelerator Pump Test

When the throttle is opened rapidly, the accelerator pump sprays fuel into the intake manifold to overcome the lag of fuel flow caused by the resulting momentary drop in manifold vacuum.

Test The Accelerator Pump:

1. While observing the CO meter, with engine at normal idle speed, quickly open and release throttle.

2. The engine should increase speed without hesitation and the CO meter should show an increase in percentage of CO.

3. If the reading decreases more than 0.5% before increasing, or does not increase, the carburetor needs either an accelerator pump linkage adjustment or a repair of the pump mechanism.

AIR PUMP TEST

On vehicles so equipped, an engine-driven air pump supplies fresh air to the exhaust manifold to allow further burning of the exhaust gases before they leave the tail pipe.

Test Effectiveness of System as Follows:

1. Bring engine to normal operating temperature.

2. Calibrate Infra-red Tester and insert sampling probe into tail pipe.

3. Operate engine at approximately 1000 RPM, depress TEST button and note HC and CO readings.

4. Maintaining the same engine speed, disconnect the air supply hose leading from the air pump to the exhaust manifold and again note HC and CO readings.

   An increase in HC and CO readings is to be expected with hose disconnected if the air supply system is operating normally. If little or no increase in HC and CO readings are observed, examine all components in the air supply system and make repairs and corrections necessary.

5. Upon completion of the tests, reconnect air supply hose and reset engine idle speed to manufacturer's specifications as necessary.

TIMING ADVANCE UNIT

The Timing Advance Unit is a power timing light equipped with a rotating indicator to measure the amount of advance of the spark due to the action of the mechanical and vacuum advance mechanism or electronic control devices. This unit is used to test or set the initial timing and to quickly test the action of the advance devices.

INITIAL TIMING

1. Connect trigger pickup to the timing cylinder, usually No. 1.

2. Place the CYCLE selector to the proper position, 4 CYCLE or 2 CYCLE.

3. Set AMPERES-DWELL-RPM knob to AUTO-TACH/DWELL.

4. Start and run the engine until it reaches operating temperature.

5. Set the engine rpm to the speed specified for initial timing.

6. Remove or disconnect vacuum hoses if speci-

fied. Plug vacuum source to prevent rpm change.

7. Set Timing Light Switch to ON, and aim timing light at engine timing marks.

8. Adjust rotating control on the back of timing light assembly until the timing mark on the rotating pulley aligns with the zero mark on the engine timing scale.

   Initial Timing should be within 1 degree of specification.

9. Replace vacuum line(s) if removed.

TIMING ADVANCE

1. Adjust engine rpm to the next desired test point.

2. Readjust the rotating control on the back of the light until the timing mark is again aligned with the zero mark on the timing scale.

3. Record timing advance indicated.

   NOTE: Reading will not include vacuum advance on vehicles equipped with a Transmission Controlled Spark (TCS) system. On most TCS systems, full vacuum advance at the distributor is not attained unless the transmission is in high gear.

4. Repeat Steps 1, 2 and 3 at each desired check point.

   Timing advance should be within specifications.

   NOTE: If desired, the operation of only the mechanical advance can be tested in the same manner as outlined above except that the vacuum line is not reconnected at the end of the initial Timing test.

MAINTENANCE AND SERVICE

OPERATOR SERVICE INSTRUCTIONS

The service and maintenance procedures presented in this section are those which the operator can perform himself. All other service should be performed by the local Sun representative.

SERVICE PROCEDURE

The 1115 is a precision diagnostic and service instrument. With reasonable care, it will provide many years of reliable service. The maintenance and service procedures presented herein do not require any special skills to perform. However, they do require care and attention to avoid any accidental damage to the equipment.

Maintaining Tester Finish

The Sun 1115 Tester has a finish of Acid and Stain resistant baked enamel and chromium plating. You can keep your tester bright and new looking by protecting its enameled and plated surfaces with a good quality automobile polish or wax. Once it has been protected with a coat of polish, it will only require a periodic wipe down with a damp cloth followed by a wipe down with a dry cloth.

Lubrication

All pumps, motors, etc. contained in the tester cabinetry are equipped with sealed bearings and require no periodic lubrication. A few drops of light machine oil every sixty to ninety days applied to the pivots and axles of the cabinet casters will keep them rolling free.

Plastic Mesh Filter Service

Fitted behind a window at left end of the tester headframe assembly is a plastic mesh filter. This filter is used to clean the air which is drawn into the headframe for cooling purposes. The filter should be removed every sixty to ninety days for cleaning. More frequent cleaning is desirable if extremely dusty conditions prevail. The filter should be washed in warm soapy water, rinsed and thoroughly dried before being reinstalled.

Infra-Red Filter Service

Two types of filters are part of the Infra-Red exhaust sampling system. These two filter elements are contained in the filter assemblies located in a recess in the right end of the tester headframe. The Primary Filter Assembly contains a 75 micron wire mesh element and the Secondary Filter Assembly contains an 8 micron composition element.

Test Lead Maintenance

The test leads and power cord are made of the finest materials available for their purpose. As with any flexible cable or hose reasonable care should be taken so as not to subject them to undue strain, high temperature or unnecessary abuse. They will retain their new appearance if they are cleaned periodically with waterless hand cleaner and wiped dry.

SERVICE AND MAINTENANCE

The exhaust sample handling system should be cleaned and serviced when the Yellow LOW-FLOW indicator under the HC Meter on the tester panel lights.

Before servicing the filters, check the Exhaust Probe that fits into the test vehicle's tail pipe to make sure the small holes at the end of the probe are open. Also, check the probe hose for excessive condensation or contaminants. The Infra-Red exhaust sampling system cannot operate properly with excessive contaminants in the system. If the LOW-FLOW indicator does not stop glowing when the exhaust probe is serviced, the filters will have to be cleaned or replaced.

When servicing the filters, be sure that all seals are properly positioned and the units are reassembled snugly to eliminate the possibility of outside air being drawn into the analyzer during vehicle tests.

Primary Filter Service

(Element should be cleaned or replaced as necessary.)

1. Remove plastic hoses from the "T" fitting on the lower part of the bowl.

2. Unscrew filter bowl from housing by turning filter bowl counterclockwise. Note position of "0" ring seal on bowl rim.

3. Turn element retainer counterclockwise and remove filter element.

4. Clean bowl and element in a solution of detergent and water and air dry. If element replacement is necessary, use Sun #301-0926 filter element.

5. Assemble in reverse order making sure "0" ring is properly positioned in groove at upper edge of bowl. Reconnect the plastic hoses to the "T" fitting. Hose from front of tester connects to the side of the "T" having the smallest opening.

Secondary Filter Service

(Element should be replaced as necessary.)

1. Remove bowl retainer at bottom of bowl by turning it counterclockwise and remove bowl.

2. Inspect "0" rings on retainer nut and bowl rim.

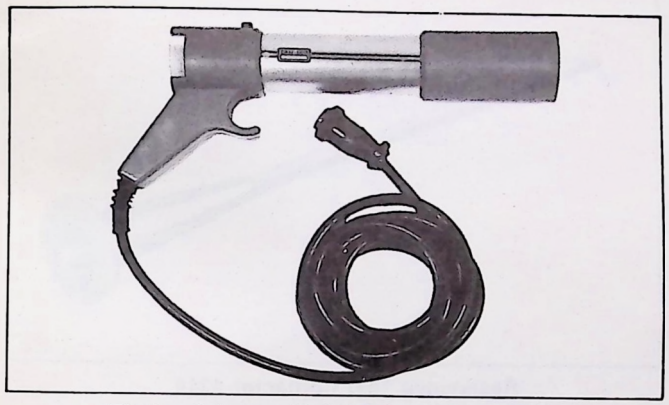
3. Remove filter retainer by pulling downward. Inspect retainer internal "0" ring.

4. Remove filter element and replace with Sun #301-0908.

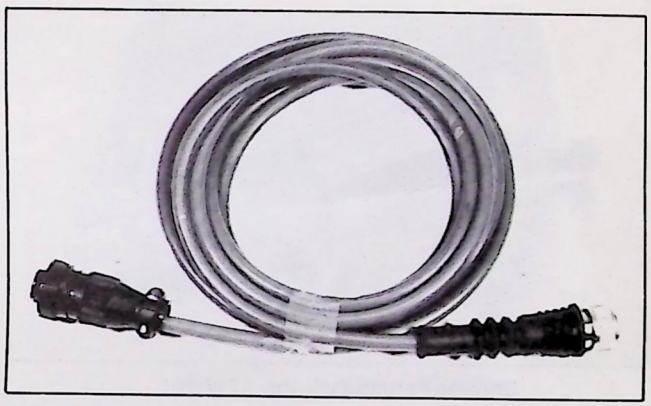
5. Wash bowl in solution of detergent and water and air dry.

6. Assemble in reverse order making sure all "0" rings are properly positioned and drain cock is fully closed.

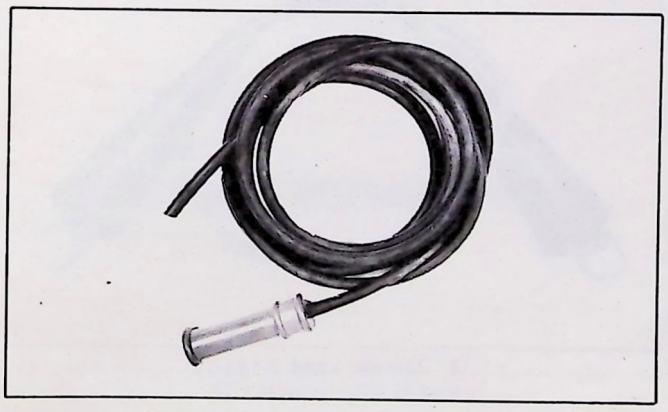
COMPONENTS AND ACCESSORIES



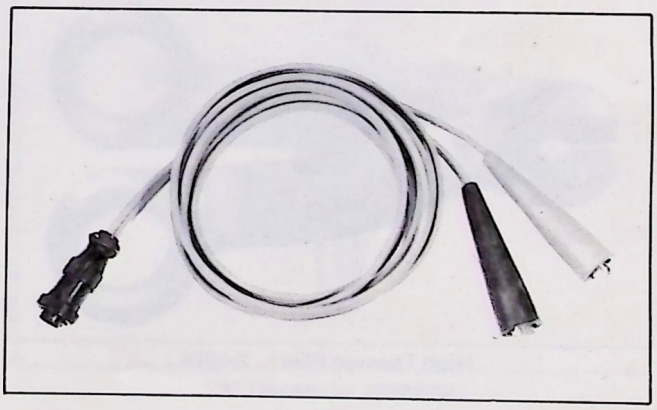
Timing Advance Unit 7010-463 [TAU-120]



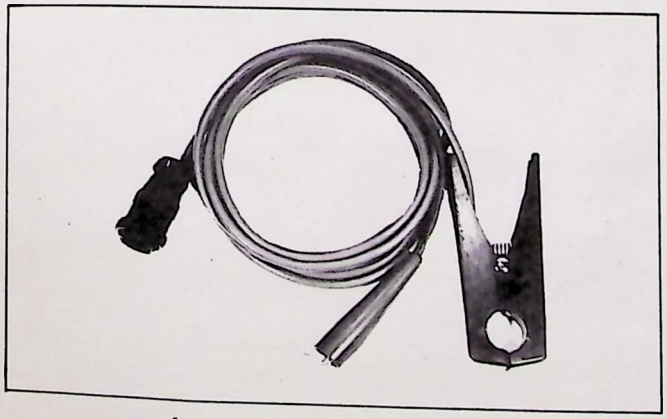
Trigger Lead 6004-262



Vacuum Hose Assembly 6006-003

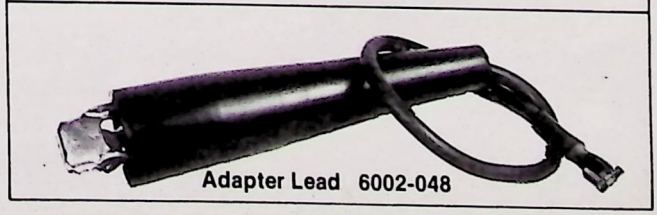


Volt-Ohmmeter Lead 6004-249



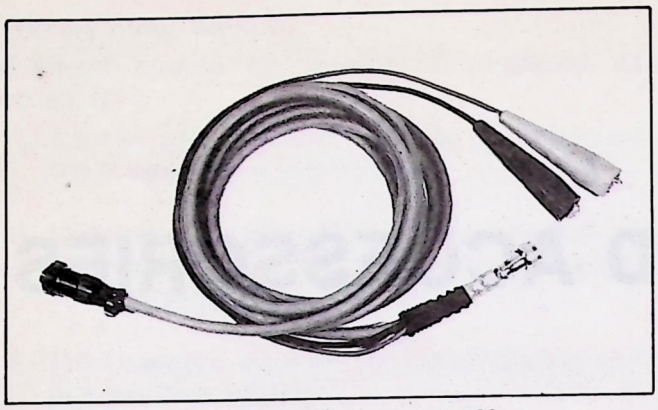
Ammeter Lead Assembly 6005-139

HEI Adapter 1747-102

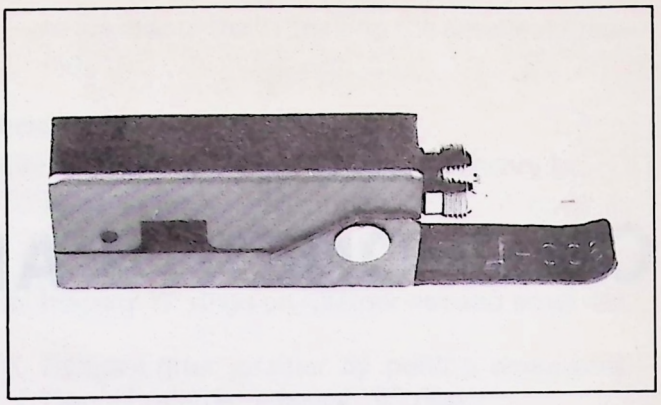


Adapter Lead 6002-048

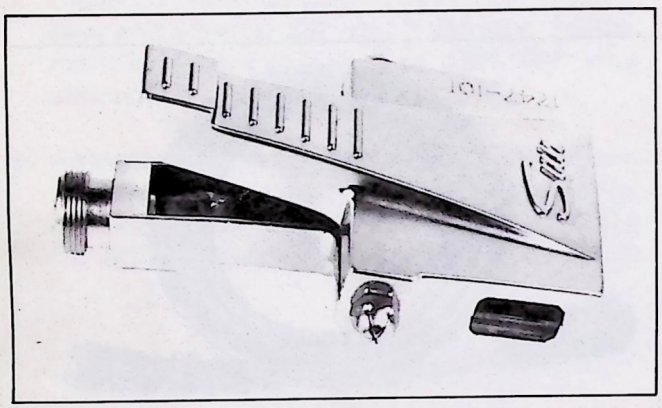
HEI Adapter Kit 0120-0240



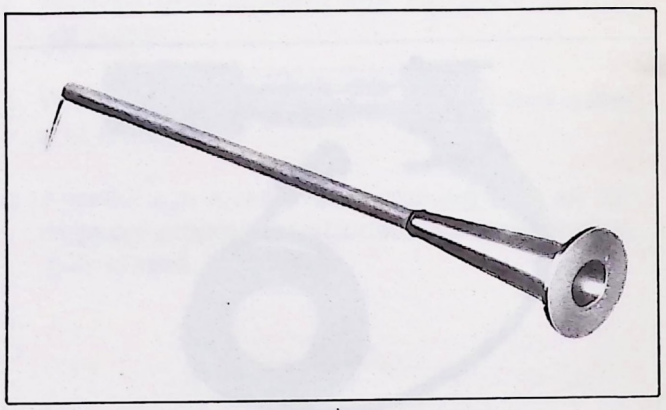
Pattern Pick-Up Lead 6005-132



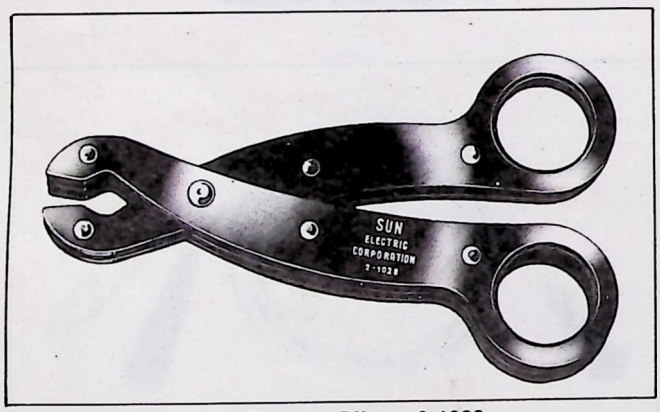
Trigger Pickup 507-6



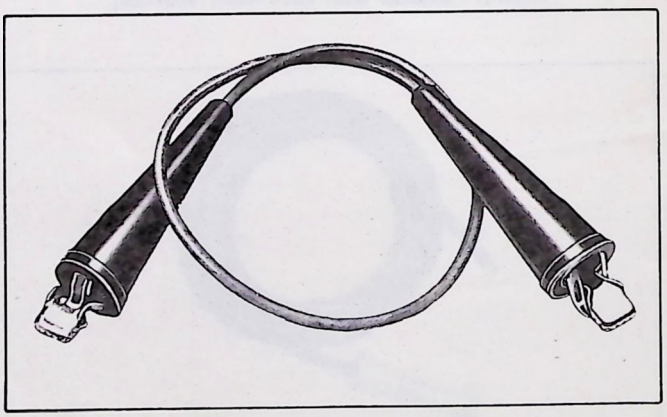
Chrome Pattern Pick-Up 1747-101



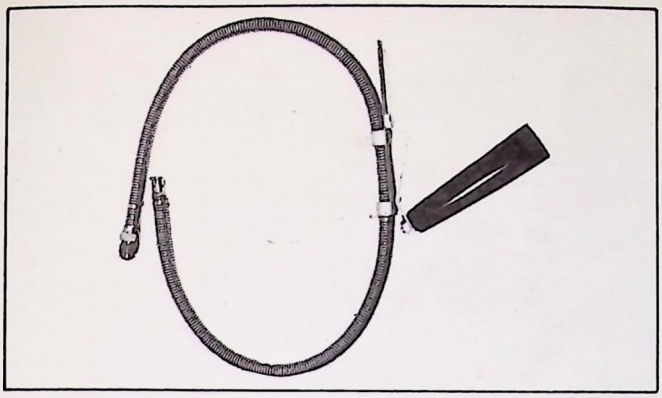
Resistance Test Contactor 4344



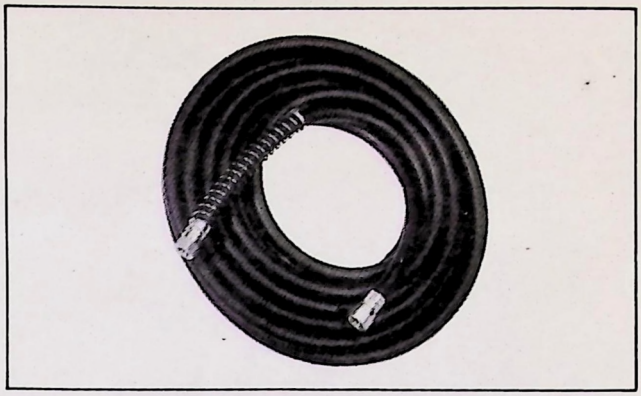
High Tension Pliers 2-1028



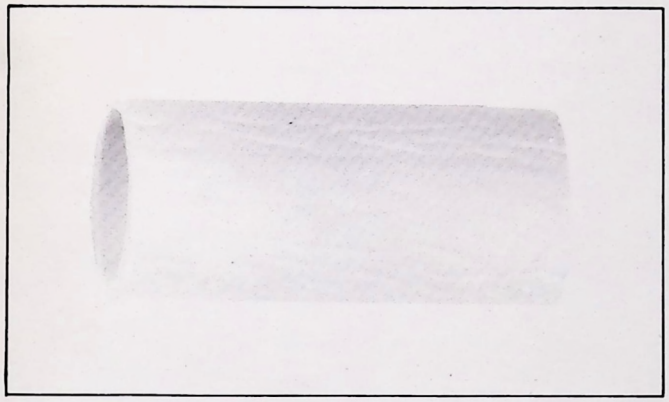
18" Jumper Lead 2-133-15



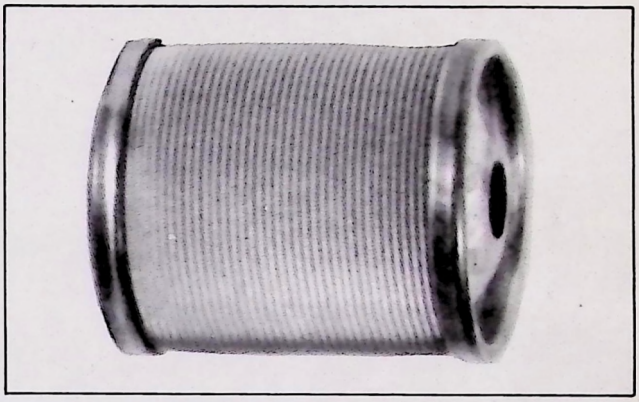
Exhaust Probe Assembly #7009-0511



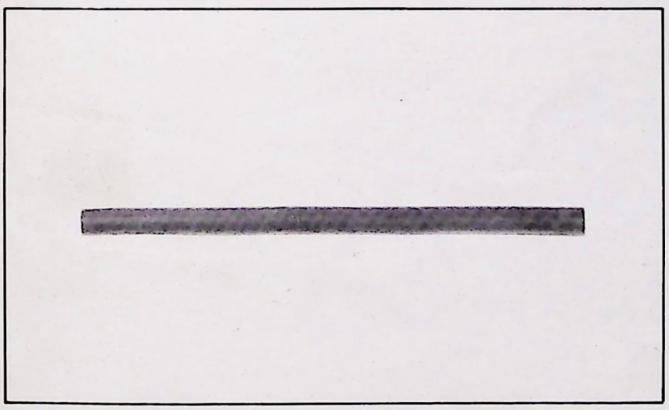
Exhaust Hose #3988-0202



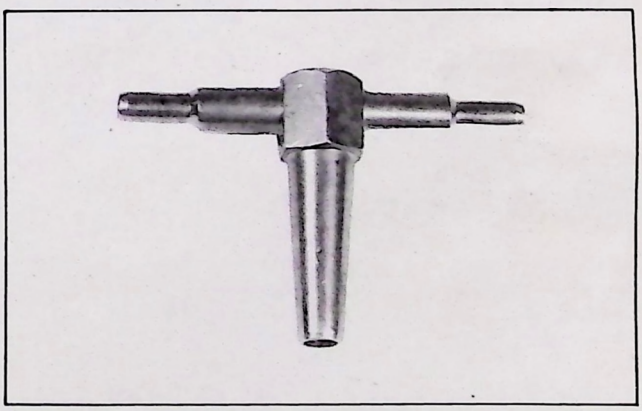
Secondary Filter Element #301-908



Primary Filter Element #301-926



6" Vacuum Hose #669-623



"T" Connector #2894-501

NOTES

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